THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XII.—No. 291.

THE APPLICATION OF ELECTRICITY TO MEDICAL PURPOSES.

IN March of last year Drs. Stone and Kilner read a paper before the Society of Telegraph Engineers and of Electricians on "Measurements in the Medical Application of Electricity." This was not only interesting in itself, but also from the fact that it was, we believe, the first of its kind which had been brought before the notice of the Society. We had thought it more than probable that these practitioners would have submitted ere this a second contribution on electricity as applied to medical purposes. Such, however, has not been the case, but we notice that Dr. Stone has supplemented to a certain extent the paper of which he was joint author with a short article in our contemporary *Nature*. We think this of sufficient interest to reproduce in our columns, and at the same time to call for some remarks.

Dr. Stone imagines that the temperature of the human body influences its electrical resistance, and this supposition is doubtless correct; but he goes further, and states his belief from his experiments that the resistance of the human body follows a similar thermal law to that influencing solid conductors, or in other words, that increase of temperature augments the electrical resistance of the body, only in a much higher ratio than is the case with solid conductors. It would appear, however, if the figures given in *Nature* are correct, that Dr. Stone's tests contradict rather than tend to prove his views. The resistance of the patient's legs from one foot to the other is given as *4,550 ohms*, at a temperature of *102·4°*; 4,780 ohms (mean) at a temperature of 104·2°; and *2,300 ohms* at a temperature of *103°*. These figures are so contradictory that it is not worth while commenting thereon beyond saying that even presuming the observations were correctly taken, single tests of such a character cannot be accepted as by any means conclusive or satisfactory. Again, the range of temperature—less than two degrees—is so small that an error could easily creep in; and as only a ten minutes' interval was allowed between three of the tests it does not follow that the temperature of the patient's body in all parts under treatment was that shown by the thermometer Furthermore, the last test was made between three and four hours after those above referred to, and although Dr. Stone is careful to mention that the measuring apparatus was left untouched so as to prevent any accidental change, it seems difficult to imagine the patient to be as little liable to alteration as inert instruments, during such a lengthy period of rest. Indeed, it appears to us that the method of making the tests, the range of temperature noted, the contacts, are all open to the admission of errors. The late Sir Charles Wheatstone had a very pretty instrument which he employed in testing the resistance of liquids in which the electrodes used set up a counter-electromotive force. It was a battery and galvanometer reverser, both reversals taking place at the same time by turning a handle, and alternating many times in a second. Such an apparatus or a commutator for reversing the ends of the *measured* resistance, as is now universally adopted in the "Wheatstone Bridges" used in the Post-office service, would be of use to Dr. Stone in his experiments. Regarding this point, the Doctor mentions that to produce accurate results the battery was frequently reversed for fear of opposition currents of polarisation. Such reversals, unless made after definite intervals and in such a way as to enable the measurements to be taken at the moment when polarisation is eliminated (as is done in testing for the locality of a fault in a broken cable), are almost useless.

One other point in Dr. Stone's interesting but unsatisfactory paper may be drawn attention to: it is stated that in making contact between the body and the testing instruments Prof. Rosenthal has drawn attention to the high insulating powers of the epidermis. We think that herein, to a great extent, lies the secret of the great difference of resistance obtained by the experimenter with a temperature difference of, say, 1° or thereabouts. We most of us know the effect of keeping the feet in salt and water, or water alone, for any length of time. The skin turns white and swells, enlarging the pores, indeed nearly the whole of the outside skin is of a spongy nature. To this cause is doubtless due the decrease of resistance shown in the Doctor's last test; for, supposing that the patient did not keep his feet in the bath during the interval between measurements, his feet would be, during the last test, in a more porous condition, and therefore the skin of a less insulating nature than at the commencement of the observations.

If Dr. Stone continues his experiments upon various human subjects he will be doing real good by giving us at least an approximate idea of the average resistance between various parts of the human frame; this will be interesting to those engaged in electric lighting with systems which are considered somewhat dangerous to life; but so much depends upon the condition of the subject that it appears very doubtful whether any two persons would have the same resistance between any two given points.

EXPERIMENTS ON DYNAMO-ELECTRIC MACHINES.

THE ELECTRICAL DETERMINATION OF THE EFFECTIVE VALUES OF THE PASSIVE MECHANICAL POWER, THE INTERNAL RESISTANCE AND THE MAGNETIC FIELD AT GIVEN DEGREES OF INTENSITY.*

THE object of these determinations is to ascertain accurately the loss of power and the electrical results in various mechanical apparatus; I have made use of various methods of determination of which I shall only quote the following summary, which is general, correct, and simple; the practical arrangement of two galvanometers, one of very low, the other of very high resistance, called electromotive force and intensity galvanometers, which I advocated in 1879, is adopted.

I would call attention to the fact that after having shown that the usual approximate laws and formulæ are, in several respects, insufficient to represent the working of the machines, and that it is necessary to take into account important reactions which are by no means neglectable, I have proved

* *Comptes Rendus.*—M. Cabanellas.

that the most accurate and the most practical method is to sum up all the effects of various kinds and to include them in one or the other of the following two effective quantities :

The effective magnetic field, the effective internal resistance ; these two quantities having to be determined by experiment.

We shall represent the effective field by the electromotive force which it produces with a given degree, for a given length or thickness of the induced circuit.

We shall call N, I the degree $_{\text{NI}}\epsilon$, $^{\epsilon}{}_{\text{NI}}$ the difference of potential at the terminals of the machine as generator and as receiver ; t, t' the powers in kilogrammetres, that indicated at the brake as a receiver and that absorbed by the passive mechanical resistances of the machine.

These are the data, all observed directly, except the last, t', which is assumed. (I shall show farther on how it is determined.)

The three unknown quantities to be determined are :— First and second, the electromotive forces as generator and as receiver, $_{\text{NI}}\text{E}$, E_{NI}, which will be furnished by the forces of the fields, which may be equal, a little different, or very different, as I have pointed out upon several occasions (notably *à propos* of the experiments of ploughing at Sermaize, and of the electrical transmission of power at Miesbach-Munich), according to the constitution of the static field ; third, the effective or *dynamic* resistance, r, which must not be confounded with the *static* resistance, a, that is to say, with the ring at rest ; r exceeds a relatively more as the speed, fineness, and length of the circuit per pair of brushes are increased ; r, therefore, takes into account, under the form, $i^2\Delta a$, the deficit of work of machines with a collector, a deficit of an electrical nature, of which I have had first the honour of giving to the Académie the indication and measurement.

From the three equations—

$$_{\text{NI}}\epsilon\,\text{I} = g(t + t') + r\,\text{I}^2,\ \text{E}_{\text{NI}}\,\text{I} = g(t + t'),\ _{\text{NI}}\text{E} = {}_{\text{NI}}\epsilon + r\,\text{I},$$

we find,

$$r = \frac{\epsilon_{\text{NI}}}{\text{I}} - g\,\frac{t + t'}{\text{I}^2},$$

$\text{E}_{\text{NI}} = g\,\dfrac{t+t'}{\text{I}}$ (gross electromotive force), and $g\,\dfrac{t}{\text{I}}$ (nett force)

$$_{\text{NI}}\text{E} = {}_{\text{NI}}\epsilon + \epsilon_{\text{NI}} - g\,\frac{t \times t'}{\text{I}}.$$

We have just assumed t' to be known ; here is a purely electrical method of determining it.

Separate the circuit of the electro-magnets from the induced circuit ; excite successively the inductor with any two currents, provided that the forces of their respective magnetic fields be not equal ; make to pass successively, by induction, a current, so that the speed becomes N, under the only passive resistant couple ; read by the galvanometers, this current i and i' and the difference of potential at the brushes ϵ and ϵ'.

Calling e and e' the gross counter-electromotive forces, and ρ the effective resistance, have the equations—

$$ei = ei + \rho i^2,\ \epsilon' i' = e' i' + \rho \overline{i'}^2,$$

and, as ei here is equal to $e' i'$, we have—

$$\rho = \frac{\epsilon i - \epsilon' i'}{i^2 - \overline{i'}^2},$$

a nd, finally, the value of ei, or $e' i'$, or gt'_{s}, is—

$$i\left(\epsilon - i\,\frac{\epsilon i - \epsilon' i'}{i^2 - \overline{i'}^2}\right),$$

or

$$i\left(\epsilon' - i'\,\frac{\epsilon i - \epsilon' i'}{i^2 - \overline{i'}^2}\right).$$

THE ELECTRICAL RESISTANCE OF THE HUMAN BODY.

[Note on the Influence of High Temperature by W. H. STONE.]*

THE experiments which I have now for some years been carrying out as to the various forms of medical electricity have begun to furnish trustworthy results. Some of these, with the help of Dr. Kilner, were incorporated in a paper read before the Society of Telegraph Engineers on March 9th, 1882. We there stated that at present "we are hardly in a position to say how far the resistance of the body varies in health ; but in disease it can be fairly stated that it sometimes diminishes and sometimes augments." Of this fact we gave illustrations.

It had often occurred to me that the temperature of the human body very probably influences its resistance ; and some experiments had been made with a view of testing the amount of such influence. But in pathological researches it is often difficult to find a case not open to exception, and it is frequently necessary to wait a considerable time before, in the impossibility of experiment, accident presents one possessing the necessary conditions. Such a case I have now met with, and it is worth while to place it on record, if only to enable other observers to prosecute this line of investigation.

The patient is a young and intelligent gunsmith aged twenty-two. He had rheumatic fever severely twelve years ago, which, as is usual in young subjects, has left permanent heart disease behind it. This did not, however, prevent his following his trade until the beginning of April in the present year. He then began to suffer from morning rigors, occurring at first at the interval of from seven to ten days, but, since Easter, daily. He came into my ward in St. Thomas's Hospital on April 28th. It is not necessary to detail the medical history of the case in a scientific periodical ; it will be sufficient to state that about 8.30 a.m. he was in the habit of suffering from severe attacks not unlike those of ague, in the course of which the temperature rapidly rose to 105° F. In the afternoon it sank to the normal human temperature of 98° or 99° F. The cause of this remarkable symptom is still somewhat obscure ; it has completely resisted the action of quinine and other antiperiodics, as well as salicylic acid, aconite, and other approved lowerers of temperature. It is probably due to ulcerative endocarditis slowly advancing. The most remarkable part of the case is that it causes the patient no suffering or inconvenience whatever. His mind is clear, and, except the feeling of chilliness during the period of heat, he makes no complaint. He is able to take interest in the determinations which I proceed to give.

It occurred to me that this unusual range of daily temperature (7 F.) afforded the opportunity I had long been seeking. But it was some time before I could arrange suitable apparatus for its examination. A hospital ward is an awkward place for Wheatstone's bridge and delicate galvanometers. Moreover I had before found that from the peculiar conditions of the human body, the testing current, to produce accurate results, requires to be frequently reversed, for fear of opposition currents of polarisation. I am glad to see a confirmation of this observation in a verbal communication of Prof. Rosenthal to the Physiological Society of Berlin on April 13th.

It was partly to overcome this difficulty that I devised, at Mr. Preece's suggestion, a dynamometer for alternating currents, of which the general arrangement was described in *Nature* some time ago. It was also brought before the Physical Society at their June meeting in Oxford. Although severely criticised by some members of that learned body, it works extremely well, and may be, I hope, an addition to medico-electrical appliances. For the purpose of the present experiment I found that an ordinarily sensitive galvanometer, considerably damped by air-resistance, was sufficient, since by the zero methods of balancing, it is only necessary just to see the deflection before commutating ; when balance is obtained, commutation has no effect on the needle of the bridge.

It would require more space than could probably be here afforded to give all details of the experiments, which, more-

* *Nature*, June 14th, 1883.

over, by the courtesy of Captain Douglas Galton, I hope to bring before the British Association of this autumn. But a brief summary of results is as follows :—

On June 5th I reached the ward at 9.40 a.m. The rigor had begun at 8.30 and was beginning to decline; I had time, however, for the following determinations :—

9.40	..	..	..	..	..	R. 4140	ohms.
9.55	..	..	..	..	..	,, 3470	,,
10.10	..	..	..	..	..	,, 2900	,,

These measurements were taken with a very small E.M.F. of about 9 volts. On June 9th I succeeded in reaching the ward during the beginning of the rigor, and took the following measurements, this time with corresponding temperatures :—

10.30 a.m.	..	..	Temp.	102° ·4	..	R. 4550
10.40 ,,	..	..	,,	104° ·2	..	,, 4630
10.50 ,,	..	..	,,	104° ·2	..	,, 4930

At this point the rigor, temperature, and resistance began to descend. I visited the patient again at

2.15 p.m.	..	..	Temp. 103°	..	R. 2300

The apparatus in these observations was left untouched, so as to prevent any accidental change. The measurement was made with a double E.M.F. to those preceding, namely 18 volts. I determined on each occasion the resistance of the leads and terminals, which I found to be on each occasion 2 ohms.

I cannot help thinking that the difference, which is as nearly as possible twice the smaller amount, is too great to be accounted for by any instrumental error, and that the human body, in spite of its large amount of liquid constituents, follows a similar thermal law of resistance to that influencing solid conductors, though in a very much higher ratio.

Only one other point requires comment, namely, the mode of making contact between the body and the testing apparatus. Prof. Rosenthal in the communication quoted above draws attention to the high insulating powers of the epidermis. In the above experiment I passed the current through the two legs, from one foot to the other, in alternate directions. The feet were previously soaked in salt and water; two large pans containing about a quart of brine each were then placed under the feet, and in each was immersed a plate of copper five inches square connected with the bridge by stout cables. I have found in other experiments that after half an hour the resistance ceases to decrease, and in this experiment it is actually increased to the amount of 480 ohms. The whole foot was immersed, its sole resting directly on the copper plate. I have two other methods of making contact in use. The first consists of rubbing the skin with the oleate of mercury; which to the diffusion power of oleic acid adds the conductivity of its base, and then immersing the part in metallic mercury. The other consists of inserting small silver claw-forceps, known to surgeons as "serrefines," through the epidermis into the tissue below. This is rather painful, but not more so than I find medical students eager in the pursuit of knowledge can and will easily undergo.

THE BRITISH INSULITE COMPANY'S WORKS.

WE lately had an opportunity of inspecting the works established at Charlton by the British Insulite Company for the manufacture of electrical appliances.

The premises cover an extensive area of ground, and comprise workshops, engine house, fitting shops, press rooms, &c.

As the operation of moulding articles of this "Insulite" requires considerable pressure, arrangements were laid down for supplying high and low pressure water to a series of hydraulic presses from accumulators kept constantly full by steam pumps. Each pressman thus has his own press completely in his control. Beside this system of high and low pressure water, is a system of pipes, through which hot air circulates, by means of which an exceedingly small amount of fuel is made to furnish the heat requisite for heating moulds and ovens to the temperature required.

One very important item of manufacture of the company is battery cells. These are seamless boxes of insulite formed by compressing the material under hydraulic pressure when warm. The complete box is made in a few seconds. The hydraulic presses are supplied with water from accumulators, and the pressure is applied very suddenly by the turn of a lever.

In other presses the lids for these boxes are formed, and one very great advantage that is claimed for these battery cells is that whereas ordinary battery cells are either

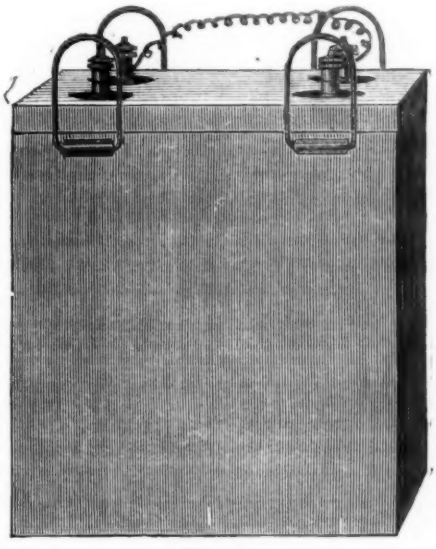


FIG. 1.

open or simply closed with pitch, these cells can be closed by a lid of the same material (insulite), perfectly soldered in and so closely joined as to prevent any "creeping" of the solutions or salts used. They are fitted up into a modified form of the well-known Leclanché.

The zinc and carbon rods project through the lid, and an ingenious form of relief valve provides for the escape of gases. These cells are made up in various sizes and sent out in sets in tin cases (see fig. 1).

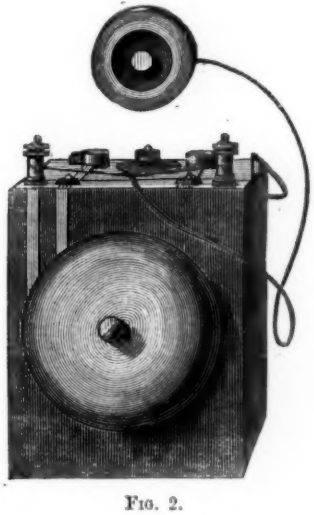


FIG. 2.

It has been found advantageous to nickel-plate the terminals, and this, combined with the fact that the cell is closed by a lid, prevents them from becoming rusty. Every one knows how quickly the ammonia chloride in an ordinary Leclanché destroys the surface of the terminals and renders a frequent application of sand-paper necessary; and it is this, combined with the irrepressible "creeping," which renders the domestic electric bell so much more sparsely used than it would otherwise be.

A very useful novelty is represented in fig. 2, the insulite sealed battery and bell combined. In this arrangement a single sealed cell is clamped by a frame to a bell-board carrying in front the electric bell. The connections between the bell and battery poles are made by strips of tinned copper, and the final terminals are screwed into the upper edge of the bell-board. The bell-wire is attached to these terminals, and on closing the circuit the bell rings.

It will be seen that any number of "pushes" and double wires can be attached to one bell, and it has the great advantage that no one, however inexperienced, can attach the

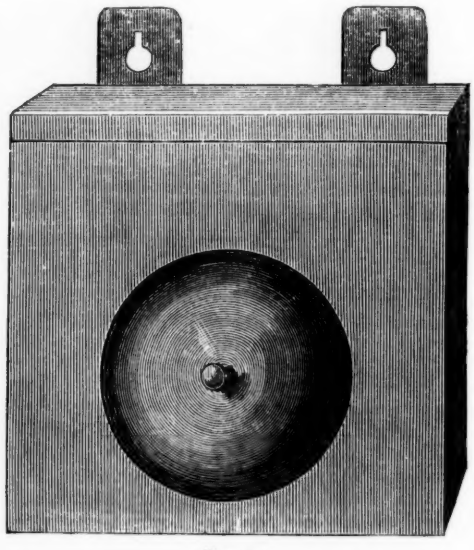


FIG. 3.

wires wrongly, there being only one pair of terminals on the whole apparatus. This combination is made up in two sizes, the cells corresponding to the No. 2 and No. 3 size of Leclanché cells. Provided with this combined battery and bell, it is in the power of any one to fit up an electric bell. The cell is sent out ready charged, and has the advantage that it can be packed up and sent by post as a parcel.

The smaller size cell is admirably adapted for working fire alarms and thief detectors.

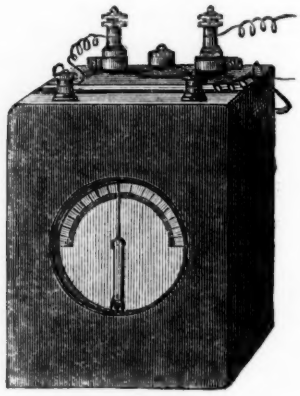


FIG. 4.

A slightly different contrivance is shown in fig. 3, in which two of the smaller cells are packed into a japanned tin case having a bell attached. This is intended for tram cars and road cars. The front of the case has a round opening cut in it, which exposes the dome of the bell, but as the dome does not protrude, all the vital parts of the bell are well under cover and out of the way of damage by weather. In its application for tram cars an arrangement has been devised by the makers so that any number of pushes can be placed in the car, and each when touched rings a bell at each end of the car. Passengers, particularly ladies, will greatly appreciate an arrangement which will make it easy to stop the car when the conductor is on the roof.

Fig. 4 illustrates a useful combination, consisting of a small sealed battery and a detector galvanometer. Every electrician has experienced the necessity for some form of little cell in the laboratory or workshop, which is always ready and in which the binding screws are not found in a hopeless state of oxidation at the moment required. Then to make a simple continuity test one has to look up a bit of wire, clean the ends, and connect up to the galvanometer. In this little arrangement it is all done for the user, it stands always ready, and as it is sealed up the connections keep clean. It is made up also with one, two, or three small cells, and a galvanometer for linesmen, whether telegraphic or electric lighters. This arrangement is also capable of being adapted for the measurement of resistance.

These applications of insulite all meet present actual wants, and will be found to meet requirements felt by the general public as well as by professed electricians.

In addition to these articles the British Insulite Company has several novelties in the way of burglar alarms and shop calls, which are capable of being attached to doors by any ordinary carpenter, and which, by the aid of these batteries and bells, render it possible for any persons to hang them up without further assistance.

ELECTRIC LIGHTING OF HOUSES.*

I HAVE shown that an electric current is produced by the expenditure of energy, and the grand principle of the conservation of energy teaches us that the whole of the energy expended is capable of being reproduced in some form, and the form in which we want it is as light. Now light and heat are one and the same thing, but perceived by us through different senses. When the temperature of any body is raised it gives off some of its heat as radiations, which begin to affect the retina of the eye and to be visible as red rays when the temperature rises to about 977° F., and as it goes on increasing the radiations given off affect the retina as yellow, green, blue, and violet, and when this point has been reached the effect of white light is produced. There are, however, very few bodies which can be raised to such a heat as to give off all the constituents of white light without being consumed, and indeed practically the only bodies which do this are different forms of carbon. Now when the electric current passes along any conductor it meets with a certain amount of resistance, which varies according to the nature of the conductor and its size, and in overcoming this resistance heat is generated. All the heat generated in a conductor except at the point where it is required to utilise it as a light is so much loss, and therefore the wires conducting the current to the points of light should have as little resistance as possible, while at the point where light is required there should be the greatest possible amount of resistance. Copper wire offers very slight resistance to the passage of the current, and hence it is used for conductors, while carbon offers very great resistance, and, as has been already stated, can be raised to a white heat without being consumed, and this therefore is the material universally employed for electric lighting purposes. The systems of electrical lighting in practical use are two—the arc system and the incandescent system, and in both carbon is the light-giving body. The arc system, though very useful under certain conditions and offering many points of great interest, is not suitable for domestic purposes, and I shall therefore confine my remarks this afternoon to the incandescent systems. It is *in this form of lighting* that the most marked advance has been made during the last two years, and no one who witnessed the many beautiful and varied applications of this system at the Crystal Palace Exhibition a year ago could fail, I think, to be impressed with the idea that a great future is in store for such a method of illumination. Now *what is incandescent lighting?* It is the power of concentrating large quantities of heat into very small foci, without the consumption of the heated body. Carbon, as I have

* Abstract of a lecture by Mr. John Slater at the National Health Exhibition.

stated, can be raised to a state of incandescence without being fused, but only on the condition that oxygen is unable to get at it, for if it does it will combine with the carbon, which would speedily burn away; therefore it is necessary to enclose the carbon in a vacuum. As the resistance of a conductor to the passage of an electric current increases as the area of the conductor diminishes, and as the greater the resistance the greater the heat produced, it follows that to obtain the best result the carbon must be of very small size, and as in its ordinary state it is much too brittle to be manipulated into the proper shape it will be evident that considerable practical difficulties had to be overcome before such a lamp as the Swan lamp was perfected. The method of construction of a Swan lamp is briefly this: Cotton thread is treated with sulphuric acid till it is reduced to a pulpy state, when it is carbonised in a furnace and becomes hard and elastic. A small portion is taken and has its ends attached to two small platinum wires fused into a little knob of glass, the carbon thread thus forming a loop. The whole is then introduced into a small globe of glass with a short neck, to the top of which the knob is attached by fusing. The other end of the globe is attached to the tubes of a Sprengel air-pump and is gradually exhausted down to a millionth of an atmosphere. This, however, is not considered sufficient, as the carbon thread may have occluded in it a small quantity of oxygen, and the wires are therefore connected with a dynamo-machine and the thread is slowly heated by the electric current and the air-pump kept at work all the time; this exhausts any residual oxygen, and the glass is fused at the point where the globe is attached to the pump, and the lamp is complete. These lamps can be made of various sizes, capable of giving a light of from one to 200 candles; and in the Swan factory at Newcastle there are now employed a large number of hands, mostly women, turning out these beautiful little articles. Although I have only described the Swan lamp, I would not be in the least understood as disparaging the other excellent forms of incandescent lamps invented by Edison, Lane-Fox, and Maxim, which differ from the Swan lamp only in small and unimportant details of construction, and in the material of which the carbon thread is composed, Mr. Lane-Fox using a kind of Italian grass used for making brooms, Mr. Edison using bamboos, and cardboard being the material used in the Maxim lamp. *Different methods* are employed for connecting the lamps with the circuit wires, but one of the simplest is to have a small knob of wood or ebony with two little hooks of platinum wire projecting from one of its faces and in connection with binding screws, to which the positive and negative wires can be attached; the platinum loops of the lamp are hooked on to those of the knob, and are kept in close contact with them by a spring.

The *readiness and ease with* which these small incandescent lamps lend themselves to any SYSTEM OF DECORATION are most striking, and a wide field is open to the ingenuity of artists and architects in arranging them in an ornamental and tasteful manner. Hitherto every one has been too much disposed to stick to the pattern of gas brackets and pendants; but as the conditions of the electric light are totally different from those of gas lighting, it would be better to strike out a new path. Whereas with gas the tubes must be of a certain size in order to admit a certain quantity, with electric lamps extremely fine wires are the carrying media, and hence great lightness of build is one of the desiderata in electric light fittings. Moreover, as the electric lamps can be placed quite close to walls, ceilings, or the most delicate decorative tints without injuring them, it is quite possible to illuminate a room by a large number of points of light fixed on the ceiling and walls without the intervention of fittings at all. I have tried this plan myself with very great effect. It is of course impossible in the full daylight of a midsummer afternoon to attempt to show artificial light; but I have here some designs for electric light fittings, which have been kindly lent me by Messrs. Winfield, of Birmingham.

With regard to the *general distribution* of the electric light to a number of houses from one central station—which I trust we shall see in practical operation before many months have elapsed—I will endeavour briefly to explain the methods of arranging lamps in a circuit. These are two: the arrangement in series and in multiple arc. In the former the lamps form what may be called a continuous bridge across the main wires and the current passes through each lamp in succession, and the total resistance to the current is the sum of the resistances of each lamp. Now, as I before pointed out, a certain amount of electromotive force is required to overcome a certain resistance, so that if there were a large number of lamps arranged in this way the electromotive force required would be very large indeed, in fact it would be quite impracticable. Another drawback is that if any one lamp were to break down, all the other lamps must go out, because the circuit would be broken. But when arranged in multiple arc each lamp is separately connected with the positive and negative wires, so that if from some accident any one lamp were to fail the others would not be affected at all, except that if they were very few in number this brightness might be slightly increased. With this arrangement the total resistance to the current is greatly reduced and is, in fact, the resistance of one lamp divided by the number of lamps. This at first sight seems rather surprising, but it can be made clearer by comparing the flow of electricity to the flow of water. Suppose two large conduits of water to be flowing near each other, but one at a much higher level than the other: if now we were to connect them by one small pipe, the pressure on that pipe would be very great indeed, but if a second small pipe were introduced the pressure on each of the two pipes would only be half what it was before, the pressure in this case being due to the resistance which the pipe offers to the free flow of water. Now you must not imagine that a current of electricity flows in the same way as a current of water does, but something analogous to what I have described takes place when we bridge across two electrical mains, between which there is a great difference of potential, in other words there being much greater electrical pressure on the positive than on the negative main, with lamps. Thus, when any central station is erected, distributing mains will be laid under streets as a double series of continuous conductors from which branch mains will be led off in various directions, and from these branch mains service wires will be taken into the houses which are to be lighted; in all cases the positive wire being connected with the positive main and the negative with the negative. The distance from the central station to which the mains can be extended, although theoretically unlimited, is practically very small indeed and will probably not much exceed half a mile in all directions. This is in consequence of the great expense of the copper mains which have to increase in size as their length increases in order to prevent their undue heating, and of course you will see that the greater the length of mains and the larger the number of houses supplied with electrical energy the more powerful will the current be which the mains have to carry, and you must never forget that all the electrical energy which goes to heat the wires is so much waste as far as light production is concerned. This shows that we need not fear that electric lighting will lead to such monopolies as gas and water have brought about. I have thus very briefly and imperfectly attempted to bring before your notice the way in which the electric current is generated and turned into light, but it would be somewhat incongruous were I to be lecturing here at the exhibition on a subject which has no particular bearing upon it, and I must therefore ask your attention for a few minutes while I endeavour to show you how important a bearing electric lighting has upon the subject of NATIONAL HEALTH. Now in considering the connection between artificial lighting and hygiene, I must recall to your attention what I said at the beginning about light being due to particles of matter being heated to a state of incandescence. We have seen that the electric light is due to the potential energy of the electric current, but in the case of gas, oil, candles, &c., their light is due to the potential energy of chemical affinity. The various kinds of wax and fat from which candles are made and all sorts of oil are rich in carbon and hydrogen, and at a certain temperature give off gases which have a great affinity for oxygen and will ignite in its presence. It is sometimes thought, no doubt, that the wick of a lamp is the burning part, but any one who has noticed what an infinitesimal portion of the wick of a good oil lamp is consumed in several hours, would soon be disabused of that idea. Thus the only difference between gas lighting and other forms of illumination is, that in the former case the gas is generated at a considerable distance from the point

where it is consumed. If the *temperature be not sufficiently high* to produce ignition, or if there be not sufficient oxygen to combine with the carbon, the gases will not ignite, but make themselves painfully evident to the senses in other ways. When they do ignite, the temperature and the amount of oxygen will determine whether the light be dull yellow or white. Hence it is evident that the combustion of any body for illuminating purposes in the ordinary atmosphere is impossible without the consumption of a considerable amount of the oxygen of the air and the evolution of a large amount of heat. Now, as soon as the oxygen has combined with the carbon, it no longer exists as free oxygen but it forms carbonic di-oxide or carbonic oxide, according as the supply of oxygen is greater or less. Every cubic foot of coal gas such as we generally have supplied to our houses, requires for its perfect combustion 1·17 c. feet of oxygen. But oxygen is just that ingredient of the atmosphere which is absolutely essential to our health and comfort, so that whenever gas is lit in a room occupied by human beings, it is taking away a large quantity of the essential element of the air they breathe, unless mechanical means of obtaining a separate supply of air for the gas are adopted. This can be done, and is done in many instances, in large halls and public buildings, but it is in our homes and offices and workshops that the greater part of our life is spent, and here it is the rarest thing possible to find any proper system of gas burning adopted. If we do not get sufficient oxygen for our lungs we suffer; if gas does not get sufficient it suffers and soon begins to recoup itself on us as the carbonic oxide which is given off is quite injurious to health.

It is hardly too much to say that it is quite an exception to find a workshop properly ventilated, and if you were to go into such a workshop where a number of persons had been at work for some hours by gaslight, you would recoil as from a blast of deadly vapour. You would see the gas-lamps all burning yellow and dim, and you would wonder how it was possible for human beings to exist in such an atmosphere. If you suggested the advisability of opening a window you would be met by a chorus of objections from every one, because the air being so much hotter than that outside, every little aperture would cause draughts which would undoubtedly be likely to affect injuriously those who had been for some time in the room. So that you would be in a dilemma in attempting to benefit the occupants. The effect of passing many hours every day in such an atmosphere as I have described is extremely lowering to the constitution in every respect, and undoubtedly diminishes the vital force besides generating disease. But it is not those alone who have to work in crowded shops who suffer from gas. Most of us occasionally require a little relaxation, and when a good play is on the boards we like to go to see it, but in nine cases out of ten most of us suffer from such a visit, except in those few cases where the new illuminant has been introduced. And even in our own houses, and much more in those of the humbler classes, in this climate of ours, which compels us even in the month of May occasionally to burn gas at midday, the effect of gas is most injurious. But with the incandescent electric light all would be changed. The heat would not be so great as with gas; but what is far more important, the light burning in a vacuum does not abstract a single particle of oxygen from the air, no injurious products of combustion are given off, and consequently there is no need of any mechanical arrangement for getting rid of them, and as the heat is less than with gas ventilation can be obtained without draughts. And there is another point to be considered, viz., quantity of light. Now I believe very strongly in having plenty of light so long as a strong direct glare is avoided, and for those who are compelled to work by artificial light it will be a very great boon that they can obtain as much light as they want of a much whiter quality than with gas. This question of whiteness in the electric light has been much debated, many people appearing to prefer the yellow light of gas. I believe this is very much the result of long-continued habit. At any rate I have been informed by a gentleman who has had more experience of the arc light—which is far whiter than any incandescent light—than any one in England, that he can work longer under it than with gaslight; and in those factories where the arc light has been introduced all who have tried it would be very sorry to go back to gas, as after getting accustomed to it the whiteness appears to give absolute relief to the eye. I therefore claim for the electric light, not theoretically but as the result of practical experience, that it is a decided sanitary improvement over the older form of lighting.

I have confined my remarks to light, but electricity when generally supplied will be a great boon as a source of motive power. At this exhibition you may see an example of a sewing machine driven by the electric current. I have no time left to dilate upon this fascinating topic of transmission of power by electricity, but it is no fanciful picture of the imagination to look forward to a time when not only will the halls of the wealthy and the large theatres of our cities be lit by the electric current, but when the poor sempstress at her work in the garret and the workman at his lathe will be able to use the same wonderful agent both to give them light without noxious gases and to work their sewing machine or other instrument by the mere turning of a tap or the pressure of a button; and in fact he would be a bold man who should attempt to predict a limit to the practical uses to which electricity may be put.

REVIEWS.

Practical Electric Lighting. By A. BROMLEY HOLMES, Assoc. M. Inst. C.E. London: E. & F. N. Spon, 16, Charing Cross.

MR. HOLMES is already known as the author of an admirable little work, entitled "The Electric Light Popularly Explained," and in our review of his compilation (see ELECTRICAL REVIEW, February 10th, 1883) we strongly recommended the book to the uninitiated public. We are pleased to be able to adopt a similar course in the case of the production now before us. This work of 154 pages and 62 illustrations, which we have read through with interest, is admirably adapted, to use the author's own words, "to explain in simple language the principles involved in the production of the light and to afford information as to the construction and working of the apparatus employed for this purpose without preference for any particular machine, lamp, or system." Indeed we but rarely come across a writer possessing a facility for explaining intelligibly electrical matters to non-electricians with such conciseness and in so few words.

The book is well calculated to make a non-scientific reader anxious to learn more on the subject of electric lighting, and therefore as a preliminary study to those of a more advanced nature we cordially advise the perusal of "Practical Electric Lighting." Could not Mr. Holmes be induced to produce a work of a little more advanced character on "Incandescent Electric Lighting?" A want is felt for such a manual, which would be both serviceable to the practical electric light engineer and to those otherwise interested in electric lighting.

TESTS OF INCANDESCENCE ELECTRIC LAMPS.

IN our issue of the 19th May, we published a letter from Mr. Henry F. Joel, C.E., in which he gave the results of some tests he had made with different measuring instruments on the efficiency of an incandescent lamp, patented some time since by Mr. Gatehouse. The tests showed an efficiency for the lamps at *20 candle-power* each, considerably higher than any which we can call to mind, that is to say, each lamp required but 51 Watts to raise it to an illuminating power of 20 candles. We suggested in an editorial note that it was probable that some error might have inadvertently crept in, which might account for such exceedingly good results. As to the lasting power of the lamps at this candle-power we had nothing to do, as only time could prove that, just as is the case with any other lamp, and until such matters have been settled by the lapse of time, we have no more reason to doubt the lasting powers of a 20-candle-power incandescent lamp *improved* in manufacture, than we have to doubt the "life" of the 16 candle-power lamps at present in use and which have not recently been the objects of such improvements.

Mr. Joel's tests, whether right or wrong, have caused a writer in our contemporary, *La Lumière Electrique*, to indulge in some hostile and personal remarks—we cannot say criticisms—towards our correspondent which, we are happy to say, are not often seen in the pages we quote from.

M. Frank Geraldy, the author of these personalities, writes as follows :—

"Mr. Joel is not unknown to us. He invented, in company I believe with Mr. Gatehouse, an open air incandescence lamp ; we know that this principle was adopted some time ago. the lamps were first made with descending carbons. M. Werdermann adopted the principle which he perfected, making use of ascending carbons ; Mr. Joel restored to its former position the lamp which his predecessor had inverted.

"These Joel lights figured at the Electrical Exhibition of 1881, they were there applied with discreetness to the illumination of one of the saloons. These antecedents are no doubt interesting, but they are not sufficient, we fancy, to make us accept all the documents emanating from Mr. Joel with closed eyes. The remark of the *Telegraphic Journal* is therefore in every way justifiable ; we should likewise be glad to know the method applied, and even to see the results investigated ; this would cast no imputation upon the writer. When extraordinary figures are announced we naturally expect them to be verified ; this is a scientific law.

"Moreover, upon consideration, these results are not so extraordinary as one would think. It must be observed, in the first place, that Mr. Joel seems to have a special affection for the Gatehouse lamp ; if he is not its father, he is certainly connected with it in some way ; he is therefore naturally affected by that increasing tendency which we meet with in almost all inventors or *quasi*-inventors and which makes them, without perceiving it, obtain high results when others would get low ones. On this head, Mr. Joel's results ought to be subjected to a co-efficient of reduction, which should be applied in the greater number of cases of this kind, and which we may call the inventor's co-efficient.

"Mr. Joel himself suggests to us another consideration. 'We know,' he says, 'that good results have been obtained with lamps raised to a high incandescence.'

"We know also, and this is really the point, that we can only determine the value of an incandescence lamp when we know its duration for a certain luminous intensity ; we will obtain for Mr. Joel at any time it pleases him, with any lamps whatever, the results which he indicates, only they will not last long: how long will the Gatehouse lamp last under the conditions announced ?

"It must be remarked, moreover, that the H.P. of which Mr. Joel speaks is an electrical horse-power, that is to say, that it represents the exact amount of energy expended in the lamps and not that produced by the machine which works them ; to obtain the true amount of work expended by this machine, the figures must be largely increased. Now when Mr. Joel refers to the eight lamps of 16 candles per H.P. with which they were satisfied, he forgets that this was per mechanical H.P., which is very different. In the Allard-Potier experiments which took place after the exhibition and of which we inserted the particulars, we find that the Edison lamps, for example, burned at the rate of 11½ lamps per electrical H.P. ; we are no longer very far from the 15 lamps of Mr. Joel, and with the aid of the inventor's co-efficient the results become less surprising.

"It is true that the Edison lamps were of 16 candle-power and that those of Mr. Joel gave 20 ; we know that photometry is very obliging ; a standard candle badly snuffed, a slight error on the right side as to distance, an error which would be raised to the square, and a small co-efficient, in this way we can pass from 16 to 20 candles without hesitation.

"I do not deny in any way the results of Messrs. Joel and Gatehouse, upon which I have no information ; only, like the *Telegraphic Journal*, I doubt them ; no one desires more than myself the progress of electric lighting, but it is certainly useless and even very injurious to give way to illusions. In the presence of results which really are extraordinary, or which are presented as such, an accurate and impartial examination is indispensable.

"There is another reason for great clearness and investigation ; the incandescence lamp has entered upon the commercial period, that is to say, upon that of inaccuracies, to put it mildly ; the watchword ought now to be 'suspicion.'"

We should not have referred to this matter were it not that we wish to correct some of M. Geraldy's statements and to call attention to the evident personal feeling which animates his uncalled-for and ill-advised expressions. In regard to the Joel-Werdermann matter we are in a position to state that Mr. Joel did not in connection with Mr. Gatehouse invent an open air incandescence lamp, but that on the other hand the latter very materially assisted M. Werdermann in the production of his now well-known system. Mr. Joel doubtless has the same affection for the incandescence lamp which is the subject of the tests under discussion, as the engineer to the Swan or Edison Companies would have for the respective lamps with which they are connected, considering that the Gatehouse lamp is the property of the Pilsen-Joel and General Electric Light Company. M. Geraldy makes the rash statement that he would obtain with any lamp whatever the results given by Mr. Joel. He however does not appear to have quite understood that which he so readily writes about, for although it is quite possible to obtain for a short time 1000 candle-power per H.P. in an incandescence electric lamp, yet we venture to say that M. Geraldy cannot give one other instance of *15 lamps* of *20 candle-power each* being produced at an expenditure of 1·018 H.P. absorbed in the lamps. In other words, can M. Geraldy point to any lamp, *previous* to the tests referred to, which would give an illuminating power of 20 candles with the same expenditure of energy in the lamp? It did not require M. Geraldy's explanation to show that Mr. Joel speaks of an *electrical horse-power*, as his figures indicate that fact.

In order that M. Geraldy may, in the future, be a trifle more cautious in his doubtless well-intentioned remarks we may state from our own knowledge that the tests made by Mr. Joel were quite independent of and without the cognition of Mr. Gatehouse, and that the latter is in no way connected with anything the Pilsen-Joel Company may choose to do with his lamp. If the lamp in question can be shown by independent tests to be as good as Mr. Joel has endeavoured to prove it to be, the result is chiefly due to the method of manufacture adopted by the company. We have so often admired the writings of M. Geraldy that although in the course of our reply to his strictures we have addressed ourselves to him, yet we cannot believe that the expressions used emanate from himself alone but rather from another quarter, and it would therefore be well if the editor-in-chief of *La Lumière Electrique* would strive to keep the columns of our usually well conducted contemporary free from these effusions, which it is but too evident are only instigated by personal motives.

THE CHLORIDE OF SILVER BATTERY.

["Experimental Researches on the Electric Discharge with the Chloride of Silver Battery." By WARREN DE LA RUE, M.A., D.C.L., F.R.S., and HUGO W. MULLER, Ph.D., F.R.S.] *

THE authors recall that at the conclusion of the third part of their researches,† they stated that they intended to make an investigation on the dark discharge, and the special conditions of the negative discharge ; this paper contains a number of experiments, more especially on the latter subject, and also others intended to throw light on the general nature of the electric discharge through gases.

The first part of the paper describes some experiments made with vessels of different forms in order to ascertain whether the dimensions and shape of the vessel have any effect on the pressure of minimum resistance to the electric discharge. This was found to be the case, for example, with a residual air charge in a spheroidal vessel 7 inches (17·8 centims.) long, and 5 inches (12·7 centims.) diameter (fig. 1), the pressure of minimum resistance was as high as 3 millims., 3947 M ; while in a tube 22·5 inches (57 centims.) long, and 1·625 inches (4·1 centims.) diameter (fig. 2), it was only 0·69 millim., 908 M ; again in a smaller tube 23 inches (58·4 centims.) long, and 0·75 inch (1·9 centims.) diameter (fig. 3), it was 1 millim., 1316 M. It is

* Abstract of paper read before the Royal Society, June, 1883.
† "Phil. Trans." Part I. vol. 171.

evident, therefore, that not only the dimensions of the tube, but possibly also the shape of the terminals, have an influence on the pressure of least resistance, and it is very probable that in the atmosphere, where lateral expansion is practically unlimited, the conditions of minimum resistance are different from those which exist even in very large tubes, and that this may influence the height of the aurora.

The paper next deals with the discharge in miniature tubes $\frac{7}{8}$ inch (2·2 centims.) long, and $\frac{1}{4}$ inch (0·63 centim.) diameter, with terminals nearly touching (fig. 4); at first it required 2,400 cells to pass, then a single cell would do so, but after standing a short time it required 4,800 cells to reproduce a discharge. In another tube $1\frac{3}{4}$ inches (4·4 centims.) long, and $\frac{3}{8}$ inch (0·95 centim.) diameter, with the terminals distant 0·00104 inch (0·0264 millim.), it required 2,240 cells to produce a discharge, then the potential had to be increased to 11,240 cells to do so. Ultimately even this number failed, but after the tube had lain by for some days, 600 cells could pass. It is very possible that the strong discharge in the first instance volatilised a portion of the terminals which were of platinum, and that this volatilised metal condensed afterwards, or else that the terminals absorbed the gas so completely as to produce a vacuum too perfect to admit of a discharge taking place; and that, ultimately, sufficient of the occluded gas was again given off to render it again possible.

In connection with the occlusion of gas by terminals, a case is described in which the terminals are of palladium, and the charge hydrogen (fig. 5). After a few discharges the terminals occluded some of the gas, and when a fresh one was produced, a volatile compound of hydrogen and palladium was given off, especially from the negative, and produced a dense mirror-like coating on the inside of the tube (fig. 6); this was re-occluded by standing for a couple of days, leaving the tube free, and again given off to form a new mirror-like coating with a fresh discharge; this property has continued since March, 1875.

The paper next describes experiments to ascertain the length of the spark in dry air and in air saturated with moisture. It was found to be practically the same in both cases. With 10,860 cells the mean length of the spark between two paraboloidal points was found to be in dry air 0·45 inch (1·1 centims.), in moist air 0·447 inch (1·1 centims.)

The next subject taken up is the discharge in a tube from two batteries, first in the same, and then in contrary directions. In the tube are two terminals at each end, one pair at opposite ends being enclosed in two short pieces of tube, 9 inches (22·8 centims.) long, and $\frac{1}{2}$ inch (1·27 centims.) diameter; the main tube being 31 inches (95·2 centims.) long and $1\frac{3}{4}$ inches (4·4 centims.) diameter (fig. 7). The various phases of the stratified discharge are represented in an engraved mezzotint steel plate copied from photographs, and show the effect of the one stratified discharge on another stratified discharge produced by a second battery. It seems that two discharges in contrary directions may take place in the same tube, and that the one modifies the aspect of the other.

Experiments are also described in a tube in the form of a cross with four arms at right angles (fig. 8); with two separate batteries connected in various ways with the different members. The experiments were made both in air and in hydrogen. By the introduction of external resistance in one of the batteries, the discharge could be readily identified as belonging to that battery by the effect of the resistance on the character of the stratification. In one of the mezzotint plates are several figures copied from photographs, which show clearly the phenomena produced. Calling the poles P and N, of one battery, A, and P′ and N′ of the other, B, it is shown in one case when two currents were equal 0·0083 ampère, that a discharge from A battery goes from P in the direction of N only as far as the junction at the cross and then turns off to N′, the negative of the other battery, B; while, on the other hand, the discharge of the B battery goes from P′ to N of the A battery. The case is different if an external resistance is introduced in one of the discharges, reducing it to 0·00087 ampère, then the discharge of the A battery goes from P to N, and that of the B battery from P′ to N′. There is a bending down, however, of the strata of the weaker discharge at the cross junction, in consequence of the action of the stronger one.

The authors remark that one cannot but be impressed, from the experiments described in the paper, and others in their former papers, by the apparent plasticity of the aggregate assemblage of molecules constituting a stratum which yields to external influences that modify its form.

The authors describe and figure a case of complex strata in the form of an outer bracket convex towards the negative (fig. 9), and close to it an inner chord; also discharges in various gases in tubes of large dimensions, 37 inches (94 centims.) long and $5\frac{13}{16}$ inches (14·8 centims.) diameter. In these the stratification, which is comparatively narrow at the terminals, extends in a conical form from the terminals to the full diameter of the tube.

They have found that the dark space in the discharge in vacuum tubes is only relatively actinically dark in comparison with a stratum, and they succeeded in obtaining a photograph of the dark space in 35 minutes as strong as that from a stratum in two and a-half seconds; consequently they conclude that the dark space is 840 times less actinically bright than a stratum.

The authors next describe a number of experiments, by means of a Thomson-Becker electrometer used on a method, to avoid leakage, proposed to them by Prof. Stokes, to ascertain the difference of potential in different parts of a vacuum tube having a number of rings sealed within it, also in other tubes of special construction. These bring out instructive information in reference not only to the relative resistances of different lengths of a column of gas at various pressures, but also forcibly to the impediment presented by the terminals themselves to the passage of a discharge from gas to terminal and terminal to gas.

It is shown that, at moderate exhausts, the resistance to the passage of the discharge is uniform along the length of the column of gas, and that at high exhausts it is not so, and that the total resistance increases but slightly with an additional length of the column; moreover, that, at these low pressures, the main impediment is in the passage of electricity between gas and terminal or terminal and gas; this is much greater at the negative than at the positive terminal.

The authors have next studied the electrical condition of a gas in the immediate vicinity of the negative terminal. In order to do this they constructed a tube $4\frac{1}{2}$ inches (11·4 centims.) long and $1\frac{7}{8}$ inches (4·8 centims.) diameter. One terminal is in the form of a point, the other in the form of a ring. The positive pole of the battery was connected with the point and the negative either to the ring alone or to earth as well; the ring terminal of the tube was, when the battery was insulated, connected with earth either by means of a stout wire or 3 feet (91·4 centims.) of fine platinum wire, 0·002 inch (0·005 centim.) diameter, and offering a resistance of 81 ohms, or a moistened cork offering a resistance of 4,300,000 ohms. In the tube were sealed three idle wires, 1, 2, 3, covered with the exception of their extremities with fine glass tubing (fig. 10). No. 1 idle wire is 0·002 inch (0·005 centim.); No. 2, 0·2 inch (0·5 centim.); and No. 3, 0·6 inch (1·5 centims.) from the ring. The ring terminal, when connected to earth, was found to be always at zero potential; notwithstanding this, there was frequently observed, more especially as the exhaust was increased, a negative potential when the idle wires were connected successively with the electrometer, amounting in one case with an air charge, pressure 0·01 millim., at wire No. 2, to 1,068 cells, at wires 1 and 3 to 912 cells. At other times a plus potential was observed. Many experiments were made to determine the precise conditions which developed a negative potential or a positive potential, but unsuccessfully, and it was inferred that this depended on the condition of the discharge itself within the tube. It is certainly very remarkable that while the potential of the negative ring was absolutely zero, that a high negative potential should be developed in its near vicinity.

The authors remark that every one familiar with the appearance of a stratified discharge will have noticed when the negative terminal is a ring, that as the exhaust proceeds a spindle of light approaches, and at last protrudes through the interior of it (fig. 11, 1, 2, 3, 4, 5); this spindle they regard as a visible exponent of strong action among the molecules of gas composing it. In order to probe its electrical condition, they prepared a tube with a central idle wire, surrounded by a minute glass tube, except its extremity,

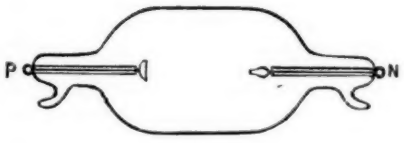


FIG. 1.

FIG. 5.

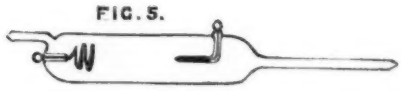


FIG. 6.

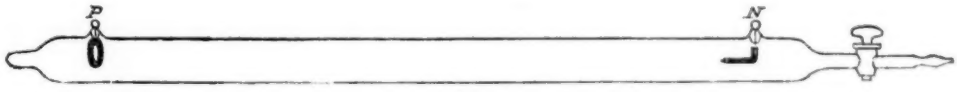


FIG. 2.

FIG. 3.

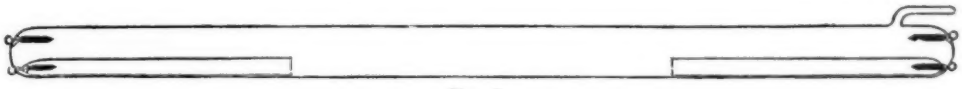


FIG. 7.

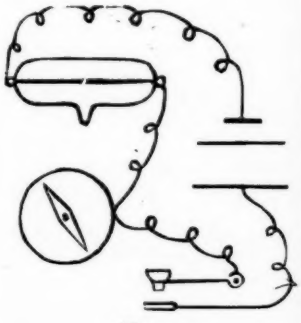


FIG.

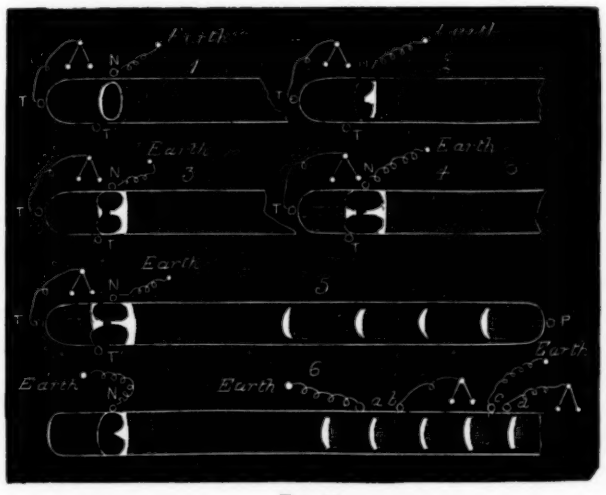


FIG. 11.

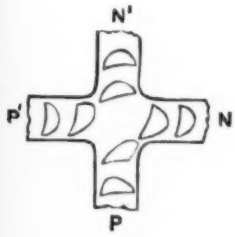


FIG. 8.

FIG. 9.

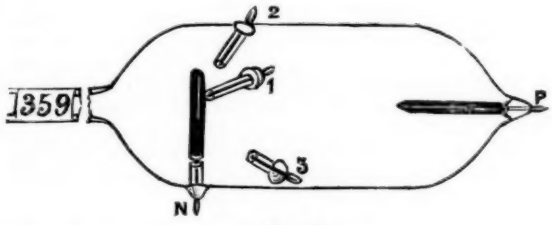


FIG. 10.

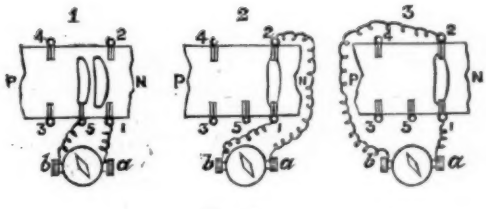


FIG. 12.

and projecting to a distance of $\frac{3}{8}$ inch (0·95 centim.) from the plane of the ring, which was made negative. Another idle wire was sealed in the tube 0·15 inch (0·38 centim.), from the periphery of the ring. As the exhaust proceeded with a charge of carbonic anhydride, the spindle approached the ring, and ultimately protruded through it. It was found that the potential of the central idle wire increased with the exhaust, until it nearly or quite equalled that of the whole tube; while that of the external idle wire was only 0·054 that of the tube.

A great number of experiments were made to test the potential across a stratum, *a*, *b*, and across a dark space, *c*, *d*, respectively, by two idle wires sealed in suitable positions in a tube, one of which was connected with earth, the other with the electrometer (fig. 11, 6). The gases used were carbonic anhydride and hydrogen respectively. As a mean of a great number of experiments it was found that when a dark space was straddled, the potential being reckoned 1, then when a stratum was straddled, the potential was 1·243, 1·229.

On testing two idle wires distant $\frac{5}{8}$ inch (1·6 centims.) apart with a Thomson galvanometer, the current in this fractional part of a tube was found to go frequently in the reverse direction to that of the main current, and when the galvanometer was connected to two idle wires diametrically opposite, currents were indicated sometimes in one direction, sometimes in another across the tube (fig. 12). These experiments seem to indicate that there are eddies in the gas during a discharge, as if the motion of the molecules conveying an electric discharge was of an epicycloidal character. The authors conclude by saying that it is possible that the eddies may be connected with the production of strata.

TELEGRAPHIC APPARATUS.

THE demand for telegraphic apparatus of every description is at the present time very considerable; indeed most of the best known manufacturing firms have just now as much work on their hands as they can find time to execute, and this in spite of the comparative depression which exists at present in the electrical world. The general design and finish of the work now turned out by the best manufacturers has decidedly undergone a change for the better within the last 10 years or so; this, of course, is but a natural consequence of the demand which has arisen for the apparatus. It is a somewhat curious fact that the earliest form of instrument used in this country, namely, the single needle, has undergone less change than any other form of instrument, whilst its employment, especially for railway purposes, shows no signs of being on the wane. In general finish the single needle instrument has certainly been altered for the better, but the general form remains much as it was 30 or 40 years ago; the length of the needles is, however, very much shorter than was originally the case, a change vitally necessary in order to enable quick working to be carried on. The greatest improvement effected in the apparatus was that introduced by Mr. S. A. Varley, which consisted in the introduction of the induced needle in the coils; this change (the patent for which has expired) was undoubtedly a vast improvement. The induced coil of Mr. C. E. Spagnoletti, which has the same object as that of Mr. Varley, is the best form yet introduced and is very extensively used. Although, as we have stated, the single needle instrument has changed its general form but very little since its first introduction, this little appears to be quite sufficient, and it is difficult to see how any further improvement can be, or required to be, effected. The fact that the instrument requires no adjustment whatever, makes it for railway purposes the very best form that can be employed.

The Morse instrument has been through a variety of stages since its first introduction, and the excellent form invented and patented by Messrs. Siemens in 1867, of which about 10,000 are now in use, does not leave much scope for improvement. This form of instrument, compared with the old clumsy embosser, is quite a contrast. Perhaps the most noticeable change which has taken place in the construction of telegraph instruments is in the proper proportioning of the various moving parts to the work they have to perform, a proportioning which is very necessary for good, and especially for fast working; the Wheatstone A B C instrument (now being to a great extent superseded by the telephone) may be taken as a pattern in this respect, and is a most remarkable piece of mechanical ingenuity. The Wheatstone automatic apparatus in its present form is also an example of an excellent arrangement of mechanism for a specific purpose, and is an instructive instrument. As we have often pointed out, the class of work involved in the construction of telegraph instruments is of a very different nature to that of ordinary mechanical engineering, though till comparatively recently this has not been sufficiently recognised; at present, however, the special character of the work is more understood, and the advantages which must result from technical education being directed to this branch of mechanism must eventually become apparent.

TOYNBEE'S ELECTRO-MAGNETIC MOTOR.

In our correspondence columns will be found an interesting letter from Mr. E. Toynbee, in which he describes a trial trip of a small electric launch he has had built for the purpose of experimenting with primary batteries and a motor of his own invention. As a description and illustration of this latter will perhaps add increased interest to Mr. Toynbee's experiences, we take the following particulars from his specification, which, together with his own brief remarks concerning his apparatus, will enable our readers to follow more readily the inventor's ideas:—

"This motor consists of a series of concentric, parallel, revolving and stationary electro-magnets, so arranged that the whole shall form one or more continuous rings of magnetic poles, enclosing the whole (or nearly so) of the magnetic lines of force, both as regards the stationary and revolving magnets. These rings may be multiplied to any extent on the same axle or spindle; the whole of the revolving (or stationary) magnets being commutated at each segment of the circle, into whatever number of segments the circle may be divided, thus producing a maximum and uniformly continuous rotary motion, from whatever source the electricity may be derived (whether from the voltaic battery or dynamo, &c., &c.), utilising the whole of the available forces both of attraction and repulsion, the force being so distributed as to act directly as a rotary power without lateral strains and without the use of any intervening gear, thus doing away with all unnecessary friction, consequently with all waste of power, obtaining an effect equivalent to from eighty to ninety per cent. of the theoretical amount of power to be obtained from a given amount of electricity. With this machine great velocities are obtained with no heating effects and a minimum of wear and tear, the only friction being that necessary to be overcome in revolving the absolute weight of the load itself.

"Fig. 1 is a longitudinal section, and fig. 2 an end view of one form of my improved electro-magnetic motor. A, A^1, A^2 and A^3 are four separate rings of field-magnets, and *a*, a^1, a^2, a^3 are their respective rings of revolving armature magnets, all arranged on the shaft, C, but each provided with a separate commutator marked respectively B, B^1, B^2, and B^3. All the commutators consist each of as many segments as there are magnets in the corresponding ring of field-magnets (which in the drawing are shown with 24 magnets each), while the armature magnets in each ring must be of such number that they are all directly opposite the field-magnets at the same time (there being 12 armature magnets shown in each ring in the drawing).

"The armature rings are arranged at intervals on the shaft, C (which must be suitably mounted in bearings at each end, and if necessary at intermediate points), so that when the magnets of one ring are opposite the pole-pieces of the corresponding ring of field-magnets, those of the other rings occupy different intermediate positions between the magnets of their respective ring of field-magnets.

"Although four sets of field-magnets and armature magnets are shown any other suitable number from two upwards might be employed and similarly arranged.

"The alternate sections of each commutator are all connected together so as to form two series, one of which is

connected to the positive poles of its corresponding ring of armature magnets, while the other is connected to the negative poles of the same.

"The wire leading the current to the armatures is connected with the commutator of each of the armature rings, and the brushes of each of them are arranged to bear on the segments of the corresponding commutators, so that when the armature magnets are opposite to the field-magnets the brushes will be resting on the insulating material between the commutator segments, so that no current will pass either through the armature magnets or the field-magnets, which

"Fig. 3 shows the method of intercepting and utilising the whole (or nearly all) of the magnetic lines of force, issuing from the magnets, and it consists in providing a series or ring of field-magnets, A, in close proximity to the front of the poles, of which the poles of the ring of armature magnets, *a*, revolve in the usual manner, and in addition thereto another series of field-magnets, F, is provided and their poles suitably arranged, one in close proximity to the outside of each pole of the armature magnets, while a third series of field-magnets, G, is suitably arranged so that their poles are in close proximity to the inside of the poles of the

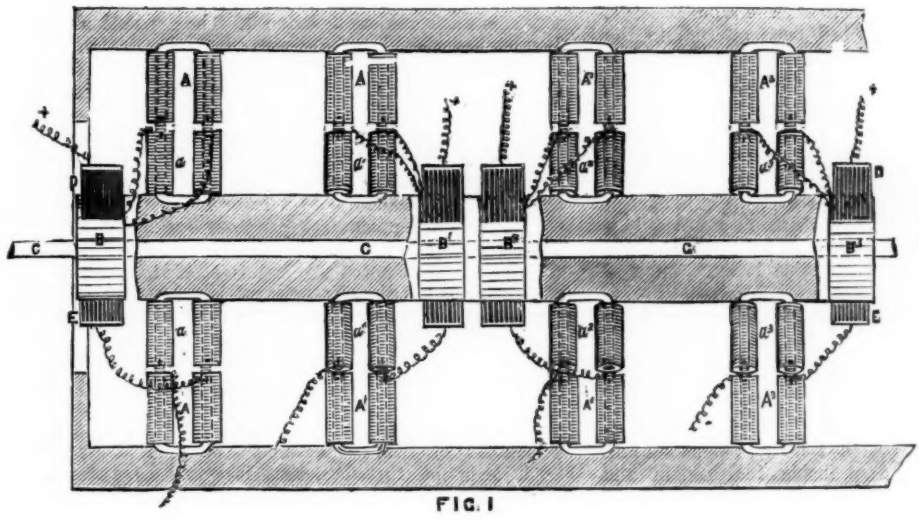


FIG. 1

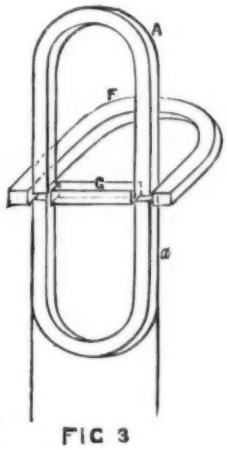


FIG 3

will be unexcited or demagnetised (or partially so) during the instant that they are in such position where they have no tendency to produce rotary motion. At the same time the whole of the magnets of the other armature rings are then in intermediate positions between their respective field-magnets (and consequently in suitable positions for producing rotary motion), and they and their field-magnets will be dividing between the amount of current previously pass-

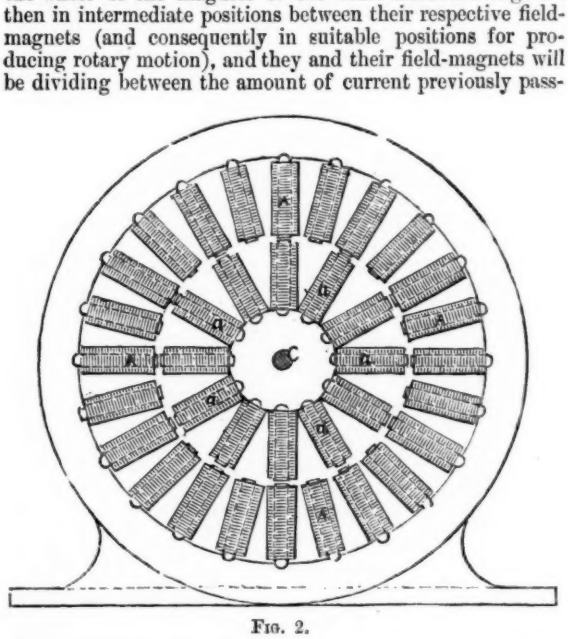


FIG. 2.

ing through the ring of armature and field-magnets which are now out of operation, in addition to their own natural amount. This action will take place successively in the whole of the armature rings and field rings, as often as the magnets of either ring are opposite each other.

"Instead of two or more rings of armature magnets and field-magnets being employed, two or more dynamo or other electric generating machines may be arranged on the same shaft in the manner herein set forth, and their commutators connected in a similar manner so as to produce the same result as that above described when used as motors.

armature magnets. It will be seen that the poles of the armature magnets are thus enclosed on all sides with the exception of their line of rotation, and the whole, or nearly all, of the magnetic lines of force will thus be intercepted and utilised, and a maximum amount of power obtained from a given current.

"It will be readily understood that both the armature magnets and the field-magnets may be of any suitable construction and form, and the details and general arrangement of the motor be varied according to requirements without departing from the principles of my invention."

NOTES.

Errata.—In Mr. Sabine's note on Electric Locomotion, at page 497, line 19 from top, for "road" read "rail;" line 20 from top, for "amount to 10 lb." read "amount to only 10 lb.;" line 1 from bottom, for "feet per second" read "feet per minute;" line 8, parenthesis should end after "pressure."

Electric Lighting.—Messrs. Ganz & Co., Budapest, have successfully installed the electric light in the spirit distillery of Messrs. Granwald & Co., at Budapest, and also put in action the installation of the sugar factory at Sokolnitz (Moravia). The same firm has made, with great success, interesting electric lighting trials on board the man-of-war ship *Custozza*, now anchoring at Drela, and has likewise fitted up the administration offices of the Austro-Hungarian Lloyd at Trieste with incandescence lighting.

The Australian Government Printing-office at Brisbane has been illuminated by the Edison incandescent lamp system.

On Tuesday one of the finest hotels in the United Kingdom was opened to the public at Glasgow. The Caledonian Central Station Hotel is one of the most prominent architectural features of the city, and its internal arrangements are magnificent and complete. No fewer than 1,200 electric bells and 600 indicators have been fitted up, and for the making of the necessary connections twenty-nine miles of

wire, weighing two and a-half tons, were used. The laundry, cellars, and engine rooms have been fitted up with Swan incandescence lamps. The advisability of lighting the whole of the building by electricity is, we believe, at present under consideration.

The Birmingham Town Hall, on the occasion of the banquet to Mr. Bright, on Thursday night of last week, was illuminated by the electric light.

The Canadian correspondent of the *Liverpool Journal of Commerce* states that the streets of Winnipeg are again lighted by electricity, the system now in use working well.

At a meeting of the Commissioners of Sewers, on Tuesday, Mr. Stoneham intimated that it had been referred to the engineer and solicitor to bring up a scheme on the subject of electric lighting, and that no time was being lost.

Our contemporary the New York *Electrician* gives the following particulars regarding the electrical illumination of the Brooklyn Bridge, which matter has already been mentioned several times in our columns. There are in all, 70 arc lamps of the Weston double carbon type, arranged in two circuits of 35 lamps each. Of these, 14 are placed on the main span, 50 on the approaches, and the remainder in the stations at each end and in the engine house. The two circuits are entirely independent of each other, and are so arranged as to take in alternate lamps entirely around the bridge. As the bridge, with its approaches, is more than a mile in length, the two circuits comprise more than four miles of line-wire. Each circuit is worked by two 20-light Weston dynamos, coupled in series and driven by an independent Corliss engine of the Watts-Campbell type. Considerable margin has been provided both in dynamos and steam plant, in view of a probable increase in the number of lights. The dynamos and engines are placed in the main engine house on the Brooklyn side. As the structure of the bridge is mainly of iron, unusual difficulties have been encountered in regard to insulation; but these have been surmounted in a very satisfactory manner, and the arrangement and erection of the circuits is especially to be commended. The wire used for the mains is insulated by a thick coating of kerite, wound with kerite tape, and the whole enclosed in a stout sheathing of braided cotton. For the main part of the bridge and approaches, the wires are carried along on the face of the trusses, over the railway tracks, and secured at intervals of a few feet by passing through cleats of wood boiled in paraffine, which are bolted to the ironwork. Where the wires pass around the buttresses at the ends of the approaches, or are brought within reach of either the foot walk or drive way, they are brought together, wrapped with a thick covering of kerite tape and enclosed in an iron gas pipe. The wires which are alongside of each other are of different circuits, the out and return wires of each circuit being on opposite sides of the bridge. The lamp-posts are mounted on the top of the trusses and the wires are taken off inside of the posts to the lamps. As the alternate lamps are entirely independent of each other, in regard both to circuits, and to dynamos and engines, the chance of any accidental stoppage of all the lights seems very remote; but in order to provide every possible safeguard, arrangements have been made for connecting the bridge circuits with the lighting stations of the U.S. Illuminating Company in New York whenever desired. For this purpose mains have been run from the stations to the New York end of the bridge, and connected with cut-off boxes in the bridge circuits, and similar cut-off boxes have been placed in the engine-house on the Brooklyn side. By closing the switches on the Brooklyn side, and opening those on the New York side, the bridge circuits are interposed as loops in the lines from the stations. The engines are to be supplied with steam from the main boilers, used for operating the railway on the bridge, and as these are not yet in place, the lights are run for the present from the Illuminating Company's station on Elm Street.

The Greenock Town Council at their meeting on Tuesday last considered the minutes of the Law and Finance Committee of date 25th May, which contained a long report by the sub-committee on the Electric Lighting Provisional Order. The deputation visited London and had an interview with Mr. Calcraft, secretary to the Board of Trade, in regard to the Provisional Order. The deputation asked that the compulsory clauses should be withdrawn, or, if not, to have the time for compulsory experiments extended from two to five years. Mr. Calcraft gave it as his opinion that he did not see why Greenock required more time to test electric lighting than was required by other burghs. If at the end of two years the Board could prove that such experiments had been made as showed an earnest desire to test the possibility of supplying electric light as a profitable commercial undertaking, the time could then be easily extended. He was quite willing, however, that the area proposed for compulsory lighting be materially reduced. Mr. Chamberlain concurred in keeping the time at two years. The draft order, with plan, was then lodged on 3rd May. The compulsory area was considerably reduced. The deputation while in London had visited several places where electric lighting was being carried on on a large scale. They had also got details of a scheme from the Telegraph Construction and Maintenance Company for the lighting of the whole of the town of Nottingham with 60,000 Swan lamps, at an estimated cost of £220,000. The estimated annual cost of working these lamps, burning 2,500 hours per annum, was £42,414, while the cost of gas, 60,000 jets (of 12 or 14 candle-power each), each burning 5 cubic feet per hour for 2,500 hours, or 750,000,000 cubic feet, at 2s. 6d. per 1,000 feet, was £93,750. This showed a difference of £51,336, or the gas was more than twice the price of the electric light. The deputation were, however, of opinion that the estimate for the cost of the electric light was in many of the items much too low. Besides, it was evident that before such a large number of lamps could be introduced, or the public could be educated to use electricity to the extent estimated, several years would elapse, and a large proportion of the capital would be idle. There could be little doubt, therefore, that it would be years before electricity would be the commercial success that gas at present was. The conclusions arrived at by the deputation were—that it was better to accept the Provisional Order with the limit of two years, that where a large number of electric lights could be introduced it was possible it might be supplied as cheaply as gas, but if the lights were to be supplied in isolated spots over a large area, it could not be supplied at anything like the same cost as gas. The committee recommended in the meantime that negotiations be entered into with an electric light company to make the proposed experiments. Water-power would be got from Prospect Hill, so that there would be the minimum of expense. The Law and Finance Committee had approved of this report, and remitted the whole matter back to the sub-committee to carry through the order.

The Duplex Electric Light Company.—The *Citizen* of last Saturday comments on this company in these terms:—"The universal criticism of the report of the Duplex Electric Light, Power, and Storage Company has given rise to two remarkable circulars to the shareholders, the one framed by Mr. Emmens, the general manager, in self-defence, and the other signed by the secretary, on behalf of the Board. We are not impressed by the wisdom of either of these documents, and we doubt if they will produce any favourable results for their authors. We take up the company's circular. The first paragraph contains a curious contradiction, for we are informed that the 'Duplex' Company was not tied down to any particular system; and yet the name would imply that one system had a strong preference. Moreover, contracts were said to be entered into for the sale of provincial concessions; but if the company possessed no special system, what had they to sell? However, the Electric Lighting Act is the source of all evil—the cause of loss and disappointment to the electric light shareholder—at least, so says our present informant. All we can remark on this point is that since *all* the electric light contractors are such sufferers by the Act, it is a pity the opposition to its passing was not more uniform and better organised. It is too late nowadays to lay the blame on the legislation, especially when many Companies and private contractors are busily engaged complying with its provisions, and apparently working thereunder at a profit. The Act in question no doubt checked the sale of so-called 'concessions' for various districts; but the only wonder is that any investors were found gullible enough to buy rights which only existed in the imagination of the vendors. It is easy enough to sell

the right to apply for an order to light a certain district; but suppose the authorities of that district oppose the order, in favour of another system? Is the Act in fault, or the speculators who counted their chickens before the eggs were even laid? Next comes the lucid statement that the stagnation consequent on the foregoing checks to business 'deprived the Company of the greater part of the capital on which it relied!' How? We should have expected stagnation would lead to the husbanding of capital. We cannot find time to plod through each paragraph of this excessively foolish circular, but that disclosing the general mismanagement of the office staff, books, and accounts of the Company is perhaps the weakest, and throws most discredit on its authors. What are Directors placed in position for, if they are not to make themselves responsible for the proper keeping of accounts, and other necessary routine of a large concern? Yet here they quietly inform the shareholders that the accounts are in disorder, that they have been misled by officials, and, finally, that the capital is gone; and that liquidation must ensue unless good money be thrown after bad. We are much mistaken if any shareholders are foolish enough to trust a halfpenny to these improvident Directors."

Combined Battery and Detector.—We would call the attention of electrical engineers who may have any rough testing to do, to the British "Insulite" Company's handy little arrangement for this purpose, illustrated in our other columns. The specimen we had submitted to us would indicate a current through 1,000 ohms in its upright form, but when laid on its back the needle would deflect 20° through the same resistance. Others may probably be more sensitive, but, in any case, the apparatus is one which recommends itself for the employment intended.

Telephonic Communication in Belgium. — The Belgian Government is authorised, by a Royal decree, dated 11th June, to work, or to let by concession, all the telephone lines in the kingdom.

Another American Telephone Company. — The Overland Telephone Company of New Jersey, with headquarters at Newark, has been organised. It holds its licence, we note, for the entire State from the parent company of the same name. A number of instruments are in operation, and the company expects to do an extensive business. The telephones are of a new pattern. Long-distance conversation is to be a special feature.

Long-Distance Telephone.—On the 12th of May, Messrs. Callanen & Parker, of Utica, experimented with their long-distance telephone on a circuit of five Western Union wires (No. 9 galvanised iron), running between Utica and Albany, a total of about 500 miles of continuous wire. The transmitter worked admirably, and was heard distinctly, says the Utica *Observer*. As the Postal Telegraph Company uses copper wire with a steel core, which has a conductivity three times greater than the No. 9 galvanised wire used by the Utica inventors, Mr. Callanen claims that his test is equal to one of 3,000 miles on a copper steel cored wire, and that their transmitter is thus three times better than the one in use between New York and Chicago.

Telephonic.—We understand that Messrs. Tancred, Arrol & Company have contracted with the Post-office for telephonic communication between their works at South Queensferry, the island of Inch Garvie, and North Queensferry. With the exception of about 300 yards, the line will be submarine.

During the construction of the New Orleans and North-Eastern railroad, the telephone was in general use. The length of the circuits was 190 miles, and no difficulty in communicating was experienced.

Telephone Patents.—From American sources we learn that the *Patent Office News*, of May 15th, says: "The Examiner of Interferences will soon render a decision in the celebrated telephone case, in which Messrs. Bell, Gray, Edison, McDonough, Dolbear, Boelker, Blake, Irwin, and Richmond, are interested. This decision will involve the settlement of eleven different cases, represented by the parties above named. Originally, there were other parties in interest, but they have dropped out, or their interests absorbed by those now actively contesting. The cases have been pending since 1878, and the arguments were made before the examiner in October, 1881, more than eighteen months ago. The testimony is embraced in five large books, and the decision of the examiner will be an elaborate and exhaustive treatment of the subject involved. The examiner has gone into the matter carefully, and his decision will cover over 700 pages of manuscript.

A New Telephone.—A dispatch from Chicago says that a new telephone, the invention of Mr. Geo. M. Hopkins, was tested on June 4th between that city and Springfield, Ill., and return, a distance of 488 miles, and that conversation was carried on with great ease and distinctness. As a severe test a book half an inch thick was placed closely against the transmitter and the conversation could still be carried on, so delicate and sensitive is the instrument. It is said that a new company is being rapidly organised, all the stock having been taken. The dispatch adds that applications for 2,500 telephones have already been made in Chicago.

Underground Conductors.—The twenty-five electrical companies of various denominations which recently met in New York for the purpose of organising a general committee for the consideration of a system for placing their circuits underground, have appointed three sub-committees to report on the electrical and mechanical devices, the law and franchises, and business organisation respectively. An American contemporary thinks that the practical difficulties standing in the way of a satisfactory underground system are probably greater in New York than anywhere else. Even if proper insulation can be secured, and induction obviated, there is the fact that the space beneath the pavement is, in very many of the streets, already fully occupied by sewers, gas pipes, water pipes, steam pipes, and pneumatic tubes, and that the number of circuits to be provided for is very great, and rapidly increasing.

Overhead Wires. — In the House of Commons recently Mr. O'Donnell asked the Postmaster-General whether he could state what precautions were taken to protect the public against the fall of the enormous and increasing mass of metal used in telegraph and telephone wires stretched over the public thoroughfares. Mr. Fawcett in reply said that only a small proportion of the overhead telegraph and telephone wires in London belonged to the Post-office, and that the majority belonged to private companies. As he previously stated, in one of the leading thoroughfares in the City, out of 97 wires, only three belonged to the Post-office. As regarded the poles and wires of the Post-office, every care was taken by frequent inspection to see that they were in proper condition.

The Shetland Telegraph Association.—This is the title of an association formed at Lerwick last week to co-operate with the Aberdeen Chamber of Commerce and other public bodies in securing greater telegraphic facilities to the islands of Orkney and Shetland. Petitions have been forwarded to the Postmaster-General and a number of influential gentlemen who take keen interest in the welfare of the inhabitants of these northern isles.

Railway Telegrams.—Mr. George Cruickshanks, Pulford, has submitted to the Postmaster-General a scheme of railway carriage telegrams, which will be taken into consideration in connection with the approaching sixpenny rate. The proposal is that telegram forms should be hung in every railway carriage, so that passengers could write messages while in transit. These messages to be collected at all important stations by a telegraph collector who would pass along the platform. In this way it is argued passengers would be able to despatch messages with respect to their

business and movements without the trouble of seeking out telegraph offices, which in many cases they have not at present time to do. *A propos* of the sixpenny telegram, this is not, it seems, to be introduced so early as was expected. A Treasury minute was laid upon the table of the House of Commons on Wednesday to the effect that it is impracticable to bring the new system into operation before the close of the year. The work entailed by it upon the department is enormous. The Treasury minute deals with the cost of the change, which, it appears, will necessitate the doubling of the plant now forming the extensive ramifications of the postal telegraphs. No material addition to the staff is, however, thought to be necessary.

Telegraphic Extensions to Fishing Stations in Scotland.—The Lord Advocate in replying to a series of questions addressed to him a short time since in the House of Commons, as to what action the Fishery Board was taking to secure telegraphic facilities for the remote fishing stations of Scotland, said this matter has been engaging the earnest attention of the Fishery Board for a considerable time past. In January last, they forwarded to the Surveyor-General of the Post-office a list of stations with which it was considered of the most importance to establish telegraphic communication, and obtained from him information as to the amount of annual guarantee that would be required for each station for seven years. The sum which Parliament has authorised the board to expend this year upon telegraphic extension, out of the surplus brand fees, is £1,000. The sums required by the Post-office for guarantees far exceeded this sum, and the board have been endeavouring to ascertain what amount of local assistance may be expected for the various stations. On the same evening the London correspondent of the *Scotsman* wrote :—"The board," I have authority to state, "are fettered in their action only by the small sum at their disposal, which, as was mentioned a few days ago, is £1,000. The offer that has been made by the Post-office is that they will construct the lines on condition that the board pays so much a-year for seven years, so that at the end of that time they will be recouped the whole expense of making and maintenance, including the cost of working, there being, however, placed to the credit of the board the sum received for outgoing messages. After being made aware of this offer, the board selected nine stations which seemed to them to be most important, and the Edinburgh Post-office authorities prepared an estimate of the sum which they would require for the construction and maintenance of these lines. This estimate showed a total cost of £4,000 and £5,000. The sum was so far beyond the means of the board that they appealed to the Home Secretary to intercede with the Post-office for its reduction. After a delay of several weeks, the Home Secretary intimated a day or two ago that he could not interfere. In these circumstances, it remains for the board to do the best they can, by trying to raise local subscriptions, and supplementing them from the money at their disposal. The nine stations selected for inquiry were Castlebay, Barra, £1,244; St. Margaret's Hope, £626; Reawick and Vaila Sound, Shetland, £281; Sillswick, £178; Westray (Orkney), £831; Whalsey (Shetland), £807; Carloway, Lewis, £191; and Port of Ness, Lewis, £262. The board, I understand, have practically resolved that the Barra line shall be taken in hand first, and that the other stations shall not be touched till this place is provided for. In aid of the Barra scheme it is expected that Lady Gordon Cathcart will give material assistance. The ground on which the preference is given to Barra is, I understand, that it is the most remote, as well as the most important station. It is feared that owing to the delay which has occurred in London, the work may not be completed in time to benefit this year's fishing very largely.

Experimenting with Electric Boats.—According to the programme of the electrical exhibition at the Franklin Institute (U.S.A.) a building will be erected on the banks of the Schuylkill in the park for electric boats to be experimented with.

Technical Schools' Exhibition at Huddersfield.—To inaugurate the opening of the Technical Schools an exhibition is to be opened the first week in July, similar to the one held last year at the Bradford Technical Schools. Messrs. Kingsland & Smith, of Leeds, engineers to the Yorkshire Brush Company, and Messrs. Ferranti, Thompson and Ince (Limited) have secured the order for the lighting up of the building during the period of the exhibition, which is expected to extend to about the end of November. For illuminating the weaving and other sheds a forty-light Brush machine will be used to operate the Brush arc lights, while a 300 light Ferranti dynamo is to be used for lighting up the rest of the building with incandescence lamps. This will be a very important piece of lighting, and we may be able to give further details respecting the installation after the work has been completed.

A New Form of Battery-Cell.—Mr. F. W. Clarke, writing to the American journal *Science*, says :—"In the ordinary voltaic element two solid plates are acted upon unequally by one or more liquids. About three years ago it occurred to me to construct a battery-cell with three non-miscible liquid strata, and no solid plates, which I did, as follows : in a small beaker-glass I placed successively layers of mercury, dilute sulphuric acid, and a solution of iodine in ether. Upon connecting the uppermost and lowest layers with insulated wires, and introducing a coarse galvanometer into the circuit, I obtained evidence of a fairly strong current of electricity. Having neither time nor opportunity to pursue the matter further, I put it on record now in order that any student who happens to be interested in the subject may carry out the investigation. Theoretically, a three-liquid cell is interesting, because its internal resistance ought to diminish with rise of temperature. In this respect it might be very different from the usual voltaic elements. Possibly a combination of solid plates with the upper and lower liquids might give a cell having an internal resistance constant for varying temperatures."

Correcting Compass Deviation.—"Some years ago," says Mr. George Iles in *Science*, "frequently recurrent shipwrecks from magnetic disturbance in the Gulf of St. Lawrence directed my attention to the subject of improving the mariner's compass, or supplementing it in some way which would make its indications trustworthy. The causes of the shipwrecks which I have mentioned seemed to be deposits of iron ore near the shore, so extensive in their area as to render the compass-reading false and misleading. The problem of improving the compass is an important one; for, apart from such risks as those which beset navigation in the Gulf of St. Lawrence, the deviation on board ship due to the presence of iron in the structure or cargo of the vessel is an element of some uncertainty and danger, even when all the devices known to the mariner's art are used to correct the readings.

"My first attempt was to so dispose a series of small flat magnets, fastened across a strip of aluminium, that the strip as such, when poised at its centre, pointed east and west.

"Poised concentrically with the strip at such a distance as to avoid mutual influence, I placed a light magnetic needle of a length equal to that of the strip. When strip and needle were near enough to a piece of iron to be attracted by it, one of the two acute angles formed by them indicated the position of the disturbing iron; and this inclination at an acute angle promised to be of value in solving the problem of correcting compass-readings. But magnetic influence on the large scale which prevails on shipboard proceeds from distant centres along large curves, in which terrestrial and local forces merge, which are not attractive, but simply directive; so that when I tried my device on a steamer under very favourable experimental circumstances, as the magnets, large and small, were directed into curves so great as to be practically straight lines, the needle and strip were always at right angles with each other. Were it feasible to use a very long magnetic strip at sea, my device might be available; but, so long as ships roll and pitch on the

ocean's unruly surface, the dimensions of the ordinary compass must remain as they are. Since abandoning the fragile little model which I launched with some expectations long ago, I have frequently reverted to the problem it was intended to solve, and it has occurred to me, that were an electro-magnet poised so as to be in constant and free communication with a battery, and were it possible to make it, when desired, so intense in its power that its induction affecting the iron of ship or cargo should increase the deviation which, when less intensely excited, would affect it, then the direction of the deviation would be, of course, known by the direction of the increase of that deviation, and the problem of correcting the compass-reading would be advanced a step. The intensity of the electro-magnet would yield such results as a long (impracticably long) magnetic strip. The electro-magnet would require to be so constructed as to be capable of developing the utmost intensity possible; and the current sent through it should be controllable at will, so that the indications at moderate and highest intensity might be compared. I have neither the skill nor opportunity to carry out the suggestion here given, and publish it in the hope that some competent man of science may be able to embody it in a practical and useful form."

Personal.—The Northern Electric Light, Power, and Appliances Company (Limited), of Dundee, has appointed Mr. Oliver Loring, from London, their manager and electrician-in-chief.

Business Notices.—On and after Monday next, the registered offices of the Indian and Oriental Electrical Storage tnd Works Company (Limited) and the Eastern Electric Light and Power Company (Limited) will be 19, Great Winchester Street, E.C.

Books on Electric Lighting.—Our readers will observe that we have spoken very favourably of Mr. A. Bromley Holmes' book, "Practical Electric Lighting," in our review this week. We must, however, protest against the exorbitant price charged for this manual, which we were not aware of when penning our remarks on its merits. The work by Le Comte Th. du Moncel on "Electric Lighting" of over 300 pages, and containing many admirable illustrations, is published (the English edition) at 2s. 6d., whilst for the little book of Mr. Holmes one is mulcted in the sum of 4s. 6d. Intending readers will therefore, no doubt, hesitate between the heavy price demanded for "Practical Electric Lighting" and our cordial recommendation of the same as an interesting elementary treatise.

Laying of Another Cable.—The Telegraph Construction and Maintenance Company has now on the way to China two ships with the Woosung-Gultzlaff-Nagasaki-Vladivostock cable, about 1,300 knots in length, which is to be laid for the Great Northern Telegraph Company.

New York Electrical Society.—At a recent meeting of this society, held in New York, Mr. William Lachlan, electrician of the Light and Force Company, of that city, read a paper on "The Faure Accumulator," in which he reviewed the history of the development of that invention from its earliest conception to the present time. In October, 1881, Mr. Lachlan lighted by electricity the fast express train running between London and Brighton and in the spring of 1882 he successfully lighted the steamship *Labrador*, of the French line between Havre and New York, the first steamship illuminated by means of storage batteries. At the conclusion of his remarks it was suggested that perhaps he could enlighten the members of the society on the subject of the actions and re-actions which take place in a storage battery, as nothing positive on the subject has yet been determined. He stated his observations on the subject; but had not yet determined to his own satisfaction what action actually does take place.

China Telegraph Lines.—A Shanghai telegram, dated May 18, says that an Imperial edict has been issued ordering that the telegraph lines between Woosung and Shanghai and between Amoy and Haihon are to be constructed only by the Chinese.

Thunderstorms.—Recently a series of thunderstorms of considerable severity has been experienced in various parts of the country. At Salford considerable damage was done to the new mills in Worsely Street, and adjoining cottages. The telephone wires leading into the offices of the mills were burned away at the instrument, but no further damage was done. In Leicester, property was damaged, but no life lost. The old hall of Lumley, near Durham, was struck, and the whole of the pictures and a window smashed. One of the gables was thrown down, the window-frames and stonework being carried a distance of 20 yards. Four men and two women and a boy were injured by the lightning. The spire of Painswick church, near Stroud, was damaged; at Christchurch, Hampshire, the post-office was set on fire; and at Llandinabo, Herefordshire, a church sustained damage, and five children were injured. From Scotland we learn that four boys standing within a stable, at Cairnbank, Duns, about half a mile from the town, were struck by lightning and stunned. On the telegraph line between Stow and Lauder, eight poles were more or less damaged.

M. Marcel Deprez.—M. Marcel Deprez, the author of the experiments on the transmission of force to a distance, has offered himself as a candidate for the place in the Academy of Sciences, vacated by the death of M. Bresse, in the section of Mechanics.

Terrestrial Currents along Telegraph Lines.—Professor Lenz is about to organise, with the aid of the Russian Geographical Society, a series of observations on terrestrial currents along four lines of Russian telegraphs—Moscow to Kazan and to Kharkoff, and Tiflis to Rostoff and Baku. These observations were highly recommended, as is known, by the International Polar Committee at its Hamburg meeting, in connection with the magnetic observations of the circumpolar stations, as well as by the Electrical Congress at Paris. Germany has already begun these observations, whilst Austria, Sweden and Finland are about to start them.

Electricians *v.* Gas Manufacturers.—At the twentieth annual general meeting of the Gas Institute, held in Sheffield last week, the President (Mr. Roberts [Ormiston Paterson) in his opening address said the practical failure of the electric light up to the present time as a competitor with coal gas had operated potently in favour of the latter, but while gas had a successful history in the past there were indications that the future would bring with it far severer trials than anything it had yet experienced. Parliament had invited electricians to lay siege to them, but they did not advance. The gas manufacturers waited their attack, and when they did come the electricians must be prepared to meet a well-equipped and stubborn foe. The gas interest would not yield one inch to them. If the electricians sought for it they might find a place for themselves.

The United Telephone Company *v.* the London Globe Telegraph and Maintenance Company.—In the Chancery Division of the High Court of Justice on Friday of last week Mr. Aston, Q.C., and Mr. Moulton applied to Vice-Chancellor Bacon to restrain the defendant company from using the Hunnings transmitter, or any carbon telephone transmitters or other instruments, being an infringement of the plaintiffs' patent as amended by their disclaimer. Mr. Hemming, Q.C., and Mr. Goodeve, for the company, undertook not to use or sell (as to Wells' instruments sent to use in this country) any Hunnings instruments not protected by the *fiat* of the Attorney-General until trial or further order, and thereupon Vice-Chancellor Bacon ordered the motion to stand over to the hearing, and intimated that he would do all that was in his power to expedite the trial.

Paper Conduits for Underground Wires.—There were sales in Wall-street the other day (says the New York *Electrical World*) of the stock of the Underground Electric Cable Company, which holds patents for paper conduits for the underground wires. The purchasers, it was said, were some of the first persons interested in the Edison electric light stock speculation, and upon the report that the Edison people are seeking to get control of the patent, the price

advanced from actual sales at $50 a share to $80 bid. The paper conduits are described as impervious to water, pliable enough to avoid breakage, proof against induction, and elastic enough to allow for expansion. They are made either as tubes or as grooved strips, laid face to face, with the grooves together.

The Gramme Electrical Company.—This company recently held its annual meeting in New York. The Edison, Brush, Fuller, Jablochkoff, United States, Weston, and Thomson-Houston Electrical Companies were represented. All of the shares voted for the following named trustees :—William H. Appleton, Leonard E. Curtis, Sherburne B. Eaton, Rowland R. Hazard, George W. Hebard, Henry I. Hoyt, William M. Ivins, Silas A. Barton, George W. Stockly. The only changes made in the advisory board of thirteen members were the substitution of Grosvenor P. Lowry, Thomas J. Montgomery, and Elihu Thomson for Calvin Goddard, Mortimer D. Leggett, and William C. Wilter. The newly appointed committees on underground communication, finance, legislation, and admissions were nearly the same in *personnel* as the ones that they succeeded. Mr. Rowland R. Hazard will continue as president of the company.

Cable Contracts.—Under a subvention from the Spanish Government, the India Rubber, Gutta Percha, and Telegraph Works Company has, we understand, commenced the manufacture, at its works at Silvertown, of a cable to be laid from Cadiz to the Canary Islands. This cable, which will be about a thousand miles in length, is expected to be finished during the autumn. The same company is also under contract to manufacture a second cable of about the same length, to be laid from the Canary Islands to Senegal. The French Government in this case contributes a considerable portion of the cost.

OFFICIAL RETURNS OF ELECTRIC COMPANIES.

Electric Sun Lamp and Power Company (Limited).—The second return of this company, made up to the 5th inst., was filed on the 13th inst. The nominal capital is £200,000, in £5 shares. 7,759 shares have been allotted to the public and 12,510 to the vendors, the latter being considered as fully paid. Two calls have been made, the first for £2 10s. and the second for £1 per share. The calls paid amount to £20,561, leaving £7,173 unpaid. Registered office, St. Margaret's Offices, Victoria Street, Westminster.

Oriental Telephone Company (Limited).—The annual return of this company, made up to the 13th of June, was filed on the 18th inst. The nominal capital is £300,000, in £1 shares. The number of shares taken up is 297,990. Upon 220,000 ordinary shares 10s. has been called and paid. Upon 2,990 ordinary shares £1 has been called and paid, and the full amount has also been paid upon 75,000 vendors' shares. The calls paid amount to £187,990. Registered office, 3, Great Winchester Street Buildings.

Hastings and St. Leonards-on-Sea Electric Light Company (Limited).—The second return of this company, made up to the 14th inst., was filed on the 18th inst. The nominal capital is £50,000, in £10 shares. The number of shares taken up is 850. Upon 683 shares a call of £10 has been made and 167 shares issued to the Hammond Electric Light and Power Supply Company (Limited) are considered as fully paid. The total of the calls paid is £6,478 15s., leaving £351 5s. unpaid. Registered office, 63, Cambridge Road, Hastings.

The Eastern Extension, Australasia, and China Telegraph Company.—This company notifies an interim dividend on the old shares for the quarter ended March 31, of 2s. 6d. per share (free of income-tax), or at the rate of 5 per cent. per annum, payable July 14 next; and also a dividend of 2s. 6d. per share (free of income-tax) on the new shares, payable on the same date. This company also intimates with reference to the issue of 50,250 shares of £10 each, at £11 per share, that after payment has been made of the final call of £3 per share on the above shares, due on the 30th instant, the allotment letter, accompanied by the bankers' receipts, may be forwarded to the company's office to be registered and exchanged for the share certificate. To enable the dividend on the shares to be paid at the same time as that on the original shares—viz. July 14—the allotment letter must be deposited at the company's office not later than the evening of July 6, when the registers will be closed. It would facilitate the exchange if the shareholders were to instruct the bank, when forwarding their call, to hand the allotment letter to the company.

Scandinavian Electric Company (Limited).—At an extraordinary general meeting of the members of this company, held at 20, Bucklersbury, on the 30th of March, it was resolved that the company should be wound-up voluntarily, and that Mr. James Edward Costello be appointed liquidator. The resolutions were confirmed at a meeting held on the 23rd of April. A meeting called by the liquidator was held on the 15th inst., when an account was laid before the members showing the manner in which the winding up had been conducted and the property of the company disposed of.

The European, American, Canadian, and Asiatic Cable Company.—This company has obtained the consent of the Canadian Parliament to change its name to the American, British, and Continental Cable Company.

The Eastern Extension Telegraph Company.—The new station of this company at Foochow has been opened for traffic. The rate for the United Kingdom is the same as to Hong Kong—viz., 8s. 4d. per word.

The Great Northern Telegraph Company.—An interim dividend on the shares of this company, at the rate of 5 per cent. per annum, will be paid on the 2nd of July by Messrs. C. I. Hambro & Son.

The Devon and Cornwall Electric Light and Power Company.—Mr. Justice Chitty has appointed Mr. Edwards, of the firm of James and Edwards, official liquidator.

The Anglo-Austrian Brush Electrical Company (Limited).—The name of this company has been changed to the International Electric Company (Limited).

LATEST QUOTATIONS.

Authorised Issue.	Share.	Name.	Paid	Closing Quotations, June 20.	Business Done.
		ELECTRIC LIGHT.			
40,000	10	Anglo-American Brush Co.	7	3¼ - 3½	3½
		Do. Do.	10	6½ - 7	
30,000	5	Australasian Electric Light, Power & Storage Co.	3	¼ - ⅜	
24,900	10	British Insulite Co., Limited, "A" Shares	5	1 - 2	1½
30,000	5	Brush Electric Light & Power Co. (Scotland)	2½	¼ - ⅜	
25,000	5	Great Western Electric Light & Power Co.	2½	⅜ - ½	
24,980	5	Hammond Electric Light & Power Supply Co.	2½	2¼ - 2½	
40,000	5	Indian & Oriental Electrical Storage Works Co.	2	..	
172,500	1	Maxim-Weston Electric Light and Power Co.	1	½ - ⅝	
..	..	Metropolitan Brush Electric Light & Power Co.	3	..	
40,000	5	Pilsen-Joel & General Electric Light Co.	2	..	
..	..	South African Brush Electric Light & Power Co.	2½	..	
100,000	5	Swan United Electric Light Co., Limited	2½	1½ - 1¾	1¾
		TELEGRAPHS.			
2,116,400*l.*	Stk.	Anglo-American, Limited	100	49½ - 50½	
2,441,800*l.*	Stk.	Do. Preferred { Def'd. receiving no div. until }	100	81 - 82	81¾-¾-¾
2,441,800*l.*	Stk.	Do. Deferred { 6 p. c. has been paid to Pref. }	100	19 - 20	19¾
130,000	10	Brazilian Submarine, Limited	10	11¾ - 12	12
16,000	10	Cuba, Limited	10	10 - 10½	
6,000	10	Do. 10 per cent. Preference	10	17 - 18	
13,000	10	Direct Spanish, Limited	9	5½ - 5¾	
6,000	10	Do. 10 per cent. Preference	10	15½ - 16½	
65,000	20	Direct United States Cable, Limited, 1877	20	12½ - 12¾	12½/16
100,000*l.*	100	Do. 6 per cent. Debenture, repayable 1884	100	99 -102	
380,000	10	Eastern, Limited	10	10⅝ - 10¾	10¾
70,000	10	Do. 6 per cent. Preference	10	13 - 13½	13 9/16
232,000*l.*	100	Do. 6 do. Debentures, repayable Oct. 1883	100	100 -102	
200,000*l.*	100	Do. 5 do. do. Aug. 1887	100	101 -104	
200,000*l.*	100	Do. 5 do do. Aug. 1899	100	104 -107	
199,750	10	Eastern Extension, Australasia & China, Limited	10	11¾ - 11¾	12.11 13-16 12
50,250		Do. New Shares, 1883	8	8¼ - 8¾	8¾
320,000	100	Do. 6 p. c. Debentures, repayable Feb. 1891	103	109 -112	
500,000	100	Do. 5 p. c. (Australian Gov. Subsidy) Deb. 1900	100	104 -107	
140,000	100	Do. do. registered, repayable 1900	100	104 -107	
100,000*l.*	100	Do. 5 per cent. Debenture, 1890	100	102 -105	
254,300*l.*	100	{ Eastern and South African Limited 5 per cent. } { Mort. Deb. Registered redeemable 1 Jan. 1900 }	100	103 -106	
345,700*l.*	100	Do. do. do. To Bearer	100	103 -106	
22,050	10	German Union Telegraph and Trust Limited	10	10 - 10½	
163,390	10	Globe Telegraph and Trust, Limited	10	7¼ - 7¾	7½
163,209	10	Do. 6 per cent. Preference	10	12¾ - 13	13¼
125,000	10	Great Northern	10	12¾ - 13	
100,000*l.*	100	Do. 5 per cent. Debentures	103	101 -104	
300,000	100	Do. 5 per cent. Debentures	100	101 -104	
31,200	10	India-Rubber, Gutta-Percha and Telegraph Works	10	30½ - 31½	31½
100,000	100	Do. 6 per cent Debentures, 1888	100	103 -106	
17,000	25	Indo-European, Limited	25	31½ - 32½	
38,148	10	London Platino-Brazilian, Limited	10	3¾ - 4¼	xd.
12,060	10	Mediterranean Extension, Limited	10	1¾ - 2¼	
8,200	10	Do. 8 per cent. Preference	10	6 - 7	
9,000	8	Reuter's, Limited	8	9½ - 10	
280,000	Stk.	Submarine	100	247 -252	
58,225	1	Do. Scrip	1	2¾ - 2½	
4,200	Cert.	Submarine Cables Trust	100	105 -109	
37,350	12	Telegraph Construction and Maintenance	12	33½ - 34½	34¼
150,000	100	Do. 6 per cent. Bonds, 1894	100	101 -103	
186,750	5	Do. 2nd Bonus Trust Cert.	2½	1⅜ - 1¾	
30,000	10	West Coast of America, Limited	10	4¾ - 5	
150,000	100	Do. 8 per cent. Debentures	100	108 -110	
69,910	20	Western and Brazilian, Limited	15	6⅜ - 6¾	6¼
		Do. Preferred	7½	5 - 5½	
		Do. Deferred	7½	1¾ - 1¾	
200,000*l.*	100	Do. 6 per cent. Debentures "A" 1910	100	106 -110	
2,500	100	Do. 6 p.c. Mort. Deb. series B of '80, red. Feb., 1910	100	100 -103	
1,500	$1,000	Western Union of U. S. 7 p.c. 1 Mort. (Building) Bds.	$1,000	122 -124	
1,030,000*l.*	100	Do. 6 per cent. Sterling Bonds	100	103 -106	
88,321	10	West India and Panama, Limited	10	1 - 1¼	
34,563	10	Do. 6 per cent. 1st Preference	10	6¼ - 7	
4,669	10	Do. 6 do. 2nd do.	10	5 - 5½	
		TELEPHONES.			
154,165	1	Con. Telephone & Maintenance, Ld. Nos. to 154,165	1	⅜ - ½	
200,000	1	Oriental Telephone Co., Nos. 80,001 to 300,000	¼	⅜ - ½	½-16ths.xd
100,000	5	United Telephone Co.	5	10 - 10½	10¼

NEW PATENTS—1883.

2857. "Systems of generation and distribution of electricity for light, heat, and power." T. J. HANDFORD. (Communicated by T. A. Edison.) Dated June 7.

2872. "Electric arc lamps." H. J. ALLISON. (Communicated by W. Baxter.) Dated June 8.

2895. "Production of light by electricity, and apparatus therefor." W. P. THOMPSON. (Communicated by R. J. Sheehy.) Dated June 9.

2922. "Electric meters." J. E. H. GORDON. Dated June 12.

2924. "A new or improved compound or material suitable for insulating and for other purposes, and method or process of manufacturing the same." A. E. LEASK and E. TORRINI. Dated June 12.

2938. "Telephonic apparatus." J. M. BETTS. Dated June 13.

2949. "Insulating wires or electrical conductors for dynamo-electrical machines, or for other purposes." J. H. JOHNSON. (Communicated by A. Chertemps & Cie.) Dated June 13.

2965. "Method of and apparatus for storing and retaining electric energy." F. J. CHEESBROUGH. (Communicated by C. T. Tomkins.) Dated June 14.

2966. "An improved apparatus for marking and telegraphing the 'score' and state of games in the game of lawn-tennis." J. H. WILKINSON and G. S. ROGERS. Dated June 14.

2978. "Means employed for creating a vacuum in the bulbs of incandescent lamps." C. H. STEARN. Dated June 15.

2979. "An electric hand tool for the use of manufacturing jewellers, engravers, and others for chasing, drilling, working, and polishing metals and hard substances, and for producing frosted and ornamental surfaces." T. H. S. HAWKER and J. W. SALAMAN. Dated June 15.

2984. "Manufacture of electric wire conductors and insulators." J. GREENWOOD. Dated June 15.

2993. "Galvanic elements." F. WIRTH. (Communicated by C. Pabst.) Dated June 15.

2994. "Electric incandescence lamps." A. M. CLARK. (Communicated by J. M. A. Gérard-Lescuyer.) Dated June 15.

2988. "Electro-motors." R. D. BOWMAN. Dated June 15.

3000. "Electric arc lamps." S. PITT. (Communicated by N. H. Egerton.) Dated June 16. (*Complete.*)

3001. "Dynamo-electric machines, systems of electrical currents, and means for producing, controlling, and reinforcing said current." S. PITT. (Communicated by N. H. Egerton.) Dated June 16. (*Complete.*)

3003. "Construction of arc and incandescence lamps, and apparatus for generating, for measuring, and for regulating electric currents, for electric lighting and other purposes." T. H. S. HAWKER. Dated June 16.

3007. "Insulators for electric wires and means for connecting them with supports." L. B. GRAY. Dated June 16. (*Complete.*)

3008. "Galvanic batteries." J. OLIPHANT, E. B. BURR, and J. W. H. R. GOWAN. Dated June 16.

3026. "Manufacture of carbon plates." R. APPLEGARTH. Dated June 19.

3031. "Improvements in the production of light by electricity and in apparatus therefor." W. P. THOMPSON. (Communicated by R. J. Sheehy.) Dated June 19.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1882.

84. "Dynamo-electric machines." W. R. LAKE. (Communicated from abroad by C. E. Ball, of America.) Dated January 6. 6d. Relates to the machine described in the number of the ELECTRICAL REVIEW for July 22nd, 1882, and March 31st, 1883.

1618. "Electric lamps." J. B. ROGERS. Dated April 3. 6d. The object of this invention is improved arrangement of incandescent or other electric lamp to render it portable and capable of being fitted temporarily at any available place or position and removable therefrom at will.

2911. "Carrying electric wires through streets." J. KINCAID. Dated June 20. 2d. According to the invention, the inventor makes a series of hollow blocks of iron, stoneware, or other suitable material, or combination of such suitable materials moulded, cast or cut into forms and sections suitable for the double purpose of (1) carrying electric wires through them, and of (2) being used also (A) for the kerbs of footpaths of streets along which it may be desired to lay electric wires for (B) the paving of streets, across or along the roadway of which it may be desired to lay electric wires. (*Provisional only.*)

4543. "Producing electric currents." F. SWIFT and A. J. M. READE. Dated September 23. 2d. The object of this invention is a new or improved means or method of producing or evolving electric currents for lighting and for general purposes without the use or employment of dynamic machines. (*Provisional Protection not allowed.*)

5019. "Iron and steel tubular telegraph poles, &c." J. C. JOHNSON and R. MARTIN. Dated October 21. 6d. Consists of improvements in strengthening iron and steel tubular telegraph poles. For this purpose the inventors use an internal supporting bar, consisting either of three or four equi-distant radial webs or plates. The said bars are produced by rolling, and are fixed in the lower part of the tubes of the telegraph poles by drawing the said tubes upon the edges of the radial webs or plates of the bars. They prefer to make the said supporting bars extend upwards about four to five feet from the socket part of the poles, but we do not limit ourselves thereto. The lower part of the telegraph pole is thus strengthened by three or four continuous ribs or supports arranged equi-distantly with the tube. Fig. 1 represents in vertical section a portion of a plain iron or steel tubular telegraph pole, the base of which is strengthened by an internal supporting bar, according to the invention and fig. 2 is a horizontal section of the same. The internal radial supporting bar is marked *b b*, and the said bar is situated and fixed in the parallel base part, *d*, of the tapering telegraph pole, *d*².

The said supporting bar, *b b*, is produced by rolling, and consists of three equidistant radial webs or plates, as represented, but more than three equidistant radial webs or plates may be used. The supporting bar, *b b*, may have a length of from four to five feet, but we do not limit ourselves to any particular length of the supporting bar. In connecting the strengthening or supporting radial bar, *b b*, to the parallel part, *d*, of the pole, the said bar, *b b*, is placed in the skelp or unwelded tube, and the tube and bar are heated to a welding heat. The tube is then operated upon by means of rolls or by tongs of the ordinary kind so as to draw the tube upon the edges of the radial webs or plates of the bar, *b b*, and thereby firmly weld the latter inside the base, *d*, of the pole, and at the same time weld together the edges and complete the joint of the said base, *d*. The lower part of the telegraph pole is thus strengthened by three (or more) continuous ribs or supports arranged equidistantly within the pole.

5023. "Carbons for incandescent electric lamps." M. BAILEY. Dated October 21. 4d. Consists in making the carbon of a tubular shape with a hollow globe in its centre which is pierced around its circumference, the wires for conducting the electric current being fixed to the sides or ends of the said carbon, the electric light being produced through the bars or partitions formed by the piercing of the globular part of the carbon by means of which it is formed into a lantern.

5035. "Lightning conductors." H. J. HADDAN. (A communication from abroad by J. Kernaul, of Munich.) Dated October 23. 2d. Consists chiefly in placing the conducting wires in grooves which are applied externally or internally to the conducting rod. (*Provisional only.*)

5050. "Electric lighting apparatus." H. H. LAKE. (Communicated from abroad by S. F. Van Choate, of America.) Dated October 23. 1s. 2d. Relates chiefly to electric lighting and comprises improvements in incandescent lamps and also in arc lamps when the electrodes of the latter are partly or wholly hermetically sealed; electrodes or light emitting conductors which may be used in connection therewith; means for removing and replacing, at pleasure, the globe of the lamp; and a simple, practical device for measuring and regulating the current in an electrical circuit and the brilliancy of an electric light, so that the current and the light may be decreased or increased at pleasure, the light being as simply and effectually regulated as an ordinary gas light. (*Too lengthy for abstraction.*)

5059. "Apparatus for applying electricity to rotary hair brushes." N. J. HOLMES. Dated October 24. 4d. Consists in an improved form of apparatus by which the inventor is able to apply an electric current generated from any of the known sources of electricity to the rotatory hair brush in such a manner that the continuity of the electric current from the generating source shall only be completed by the pressure of the brush on contact with the head in the act of brushing the hair, by which means the system of the person operated upon forms a portion of the circuit and shocks or currents of electricity are caused to pass into the body at the points of contact of the brush with the head or body of the person operated upon.

5092. "Electric generators." E. JONES. Dated October 25. 2d. The object of this invention is to construct electric generators for illuminating and other purposes in a more simple and economical manner than heretofore, and it relates more particularly to a novel construction of armature which may be run at a high speed, and by the use of which the efficiency of the generator will be increased (*Provisional only.*)

5097. "Secondary batteries." R. HAMMOND and L. GOLDENBERG. Dated October 26. 2d. Relates to what are known as secondary batteries, and it is designed to form them ready for charging by purely chemical, in place of electro-chemical, means. The batteries are formed as follows:—The inventors permeate the surfaces of a leather or skin plate, previously soaked in sulphuric acid, with a mixture of lead peroxide and sulphate, obtained by the treatment of minium by sulphuric acid. They enclose this in frames of lead or platinum as poles. (*Provisional only.*)

5098. "Electric lamps." A. MACKEAN. (Communicated from abroad by A. Kryzsat, of Moscow.) Dated October 26. 2d. Relates to arc electric lamps. The invention consists in the arrangement, construction, and combination of certain parts. (*Provisional only.*)

5105. "Electric lighting, &c." P. CARDEW. Dated October 26. 10d. Has for its object improvements in electric lighting and in apparatus connected therewith. The first part has reference to the means of producing, measuring and regulating the supply of the electricity and consists of improvements in the winding and arrangement of the magnetising coils of dynamo machines by means of which it will be possible to connect any number of arc lamps in what is known as divided circuit or multiple arc without one lamp interfering with the burning of another, and also when burning incandescent lamps of an improved means of insuring the right amount of current in every lamp whatever its distance from the machine. To effect this the inventor takes a dynamo machine of any size, say one calculated to give 80 ampères of current and having a revolving armature wound to a suitably low resistance. In such a machine the magnetising coils would usually be of very large wire capable of carrying this current without overheating. In place of this the inventor winds these coils with several, say, 8 different wires capable of carrying $\frac{1}{8}$th of the total current or 10 ampères. These several wires may be each partly wound on each bobbin of the coils or the bobbins may be wound with these wires in any other convenient way, care being taken that the magnetising effect of each wire is in the proper direction. One end of each of these coils is connected to one of the brushes of the machine and the other end of each is brought to one of a row of eight terminals. Thus the current divides from the brush and can be taken from the terminals to as many lamps, the other poles of which are joined to a large lead common to all and leading back to the other brush of the machine.

5108. "Galvanic batteries." P. R. DE FAUCHEUX D'HUMY. Dated October 27. 6d. The invention has for its object improvements in galvanic batteries and relates to novel constructions and arrangements whereby a battery or series of batteries can when required be instantaneously put out of action by withdrawing the exciting liquids from the cells or chambers containing the same.

5122. "Electric current generators and motors." S. P. THOMPSON. Dated April 27. 1s. 2d. The first part of the present invention relates to a type of dynamo-electric machine which can be used either as a generator or as a motor, and is an improvement upon an early machine described by Faraday in papers read by him before the Royal Society in the year 1831, and since published in the work entitled "Faraday's Experimental Researches in Electricity." The second part of the invention relates to an improved form of dynamo-machine to serve as a generator or motor, wherein the castings which serve as cheeks and cores for the field-magnets also form the bed-

FIG.1

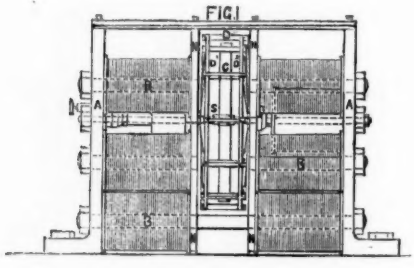


FIG.2.

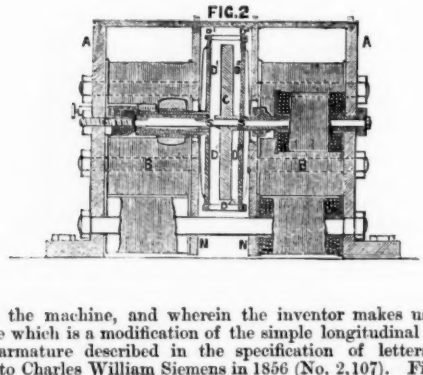


plate of the machine, and wherein the inventor makes use of an armature which is a modification of the simple longitudinal shuttle-shaped armature described in the specification of letters patent granted to Charles William Siemens in 1856 (No. 2,107). Fig. 1 is a side elevation. Fig. 2 is a vertical longitudinal section, and fig. 3 is an end elevation of the said machine. Fig. 4 is a side view of one of the armature discs. The discs, D^1 D^2, are preferably of copper and are cut or slit radially as in fig. 4, and may be strengthened at the back with radial ribs. The said discs are joined at the periphery by bridges, D*, as shown in figs. 1 and 2, and rotate together (like a loose wheel or pulley) upon a fixed shaft or axle, S, of iron or steel. This shaft is a part of the electro-magnets, and in some cases coils are placed on one or both of its ends to induce magnetism in it. The middle part of the said shaft must be a pole of opposite sign to that of the pole-pieces, N, N, of the peripheral field-magnets. These peripheral magnets are arranged, as shown, with their cores, B, parallel to the shaft, S, and are united into two groups, one on the right, the other on the left of the machine, being held in their places between the circular iron cheeks or pole-pieces, N, N, and the end-plates, A, of the machine, through which the cores pass and are secured by screw-nuts as shown. The circular pole-pieces, N, may be connected at their peripheries by iron plates or masses so that the rotary armature will be enclosed thereby. In order that the lines of force of the field may be cut squarely by the rotating disc-armature, one or more circular plates, C, of soft iron are placed on the middle part of the said shaft, S, within, or between, the two discs of the armature. The compound disc-armature may then be said to consist of three parts, viz., the discs, the bridges, and an internal mass of iron, which, though an important and essential feature of the armature, need not rotate with the other parts thereof. In this arrangement each of the two discs rotates, as in Faraday's machine, between magnetic poles. But, since in the machine the motion as viewed from the respective ends of the axis is, of one disc a right-handed

FIG.3.

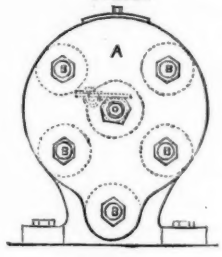
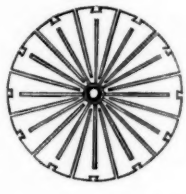


FIG.4.



rotation, and of the other disc, a left-handed rotation, the induced radial currents will flow in one disc from centre to circumference, and in the other disc from circumference to centre, as required; tubular or other suitable attachments must therefore be added to the discs for the conveyance of the currents; one or both of the said tubular attachments must be insulated from the aforesaid shaft or axle by the insertion of an interior tube of non-conducting material, such as vulcanised fibre; and upon the outer surface of such insulated attachment, or a smooth metal pulley placed thereon presses a "brush" which is provided to collect the currents. In some cases one such brush only is used, the attachment of the second disc being uninsulated, so that the current enters or leaves through the shaft or axle of the machine; in such a case the said shaft or any part of the machine in metallic contact with it, may be used as a second terminal. The framework of the field-magnets at either end may be cast in one piece with their cores, B, and the united framework may serve also as a bed-plate for the machine. The field-magnets may be wound and excited in any of the ways adopted in ordinary dynamo-machines, the coils being joined either in series with, or as a shunt to the external circuit; or they may be separately excited, or they may be excited by any method involving a combination of these ways; or they may be replaced by permanent magnets.

5126. "Telephonic apparatus and electric call bells." H. G. ELLERY and J. T. GENT. Dated October 27. 4d. This invention relates first to improvements in telephone receivers. In carrying out this part of the invention instead of a diaphragm of metal capable of being acted upon by undulatory magnetic currents, and itself capable of producing induced currents by its vibrations when in proximity to a magnet, the said diaphragm being usually an iron disc placed at right angles to the length of the magnet, and resting, so far as its circumference is concerned, upon the wooden cases, and firmly secured by the cap or cover, it is proposed to substitute a thin bar of iron or steel, slightly curved and of sufficient length to rest with its ends in cavities provided in the sides of the cases containing the magnet; in these cavities are inserted small pieces of metal, upon which the ends of the bar rest, and which allow them to move freely when set in motion by the vibratory currents of the magnet; the grooved cavities must be of sufficient depth that when the cover securing the tympan is fastened to the case the curved bar is free to lengthen outwards when brought nearer the straight line by the action of the magnet, near to the face of which it rests, but not in contact therewith. (*Provisional only.*)

5129. "Compositions for insulating conductors of electricity, &c." C. W. TORR. Dated October 27. 4d. Consists of the new or improved compositions, which compositions are especially suited for

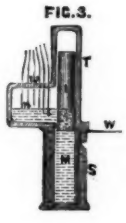
insulating conductors of electricity but are also applicable to other purposes such, for example, as the construction of insulating stands or supports for bodies charged with statical electricity. The essential constituents of the compositions constituting the invention are pitch, resin, and sand. These are mixed in the proportions of about one part by weight of pitch, one part by weight of resin, and two parts by weight of sand. The mixture of these materials is heated until the pitch and resin are melted, and the semi-liquid mass is stirred until the melted pitch and resin are thoroughly incorporated and the sand thoroughly mixed therewith. The composition may either be applied directly, that is without solidifying, to the particular purpose for which it is required, or it may while in a melted state be cast in moulds so as to form, on cooling, blocks which may be stored until wanted and re-melted for the purpose of applying the composition to the insulating of electrical conductors or cables or other purposes.

5158. "Apparatus for producing and regulating electricity." J. D. F. ANDREWS. Dated October 30. Relates to apparatus for producing electricity and for regulating its production and application to lighting and other purposes. For producing electricity, the inventor employs a dynamo-electric machine, constructed and arranged as shown by fig. 1, which is an end view, and fig. 2, which is a plan of the rotating armature and commutators. A, A, are the electro-magnets presenting two opposite polar fields, between which rotates the armatures, consisting of a cylindrical barrel of non-conducting material, having fixed on its circumference, side by side, a number of copper bars, *a*, parallel to the axis of the barrel. These bars, *a*, are connected together in series, that is to say, one end of each bar is connected to the bar in front of it, and the other end is connected to the bar behind it as indicated at *c*, c^1. At each end of the barrel is fixed a commutator, *b*, b^1, consisting of half as many insulated plates or segments as there are bars, and each of those plates is connected to a junction, *c*, c^1, of the armature bars, *a*. According to another arrangement, the inventor keeps the bars, *a*, insulated from each other along their whole length, and he provides each of the commutators, *b*, b^1, with as many insulated plates or segments as there are bars, connecting one end of each bar, *a*, to a plate of *b*, and the other end to a plate of b^1. Each commutator has as usual a collecting brush or rubber, *d*, d^1. In cases where the armature rotates through more than one set of magnetic fields, the inventor applies to each of the commutators as many brushes as there are sets of fields. These brushes may be duplicated or arranged in pairs, one of each pair serving to collect the currents generated as the bars approach the successive magnetic fields, and the other to collect the currents generated as the bars recede from the successive fields. The arrangement of a commutator at each end of the armature with its appropriate

FIG.1.

FIG.2.

FIG.3.



brushes may obviously be applied in cases where, instead of bars, coils of insulated wire are wound on the armature, as in many known machines, and in such cases also the brushes may be duplicated as described to collect the currents generated during both the approach and the recession of the coils relatively to the magnetic fields. For the purpose of regulating the production or the application of electricity at some convenient part of the circuit, the inventor divides the conductor into a number of branches, each having introduced into it a resistance, and he brings the conductors from all these branches to a position where they lie parallel to each other, but each a little shorter than the next in order, so that a conductor moved over them will make contact with one, two, three or any number of them, and so bring into the circuit a less or greater number of the branches. The conductor may be moved by hand or automatically, and it may either be a bar of conducting metal or it may be mercury. When mercury is employed the automatic regulating apparatus is arranged as shown in vertical section at fig. 3. A vessel containing mercury, M, is coiled with insulated wire, S, so as to form a solenoid, having an iron core, I, floating partly immersed in the mercury and raising or lowering its level, *m*, according as it is attracted more or less down into M. One lead of the circuit is divided, as above described, into a number of separate wires, *w*, each shorter than the next in order; the other lead, W, is connected to the mercury. The farther I is attracted downwards, the higher is the level, *m*, of the mercury raised so as to make contact with a greater number of the wires, *w*. The coil, S, may be in the main circuit or in a by-pass, or it may be a duplicate coil, one in the main circuit and the other in a by-pass, with opposite currents, tending more or less to neutralise each other; or instead of the coil, S, or in addition to it, there may be a coil on T attracting I upwards, according to the conditions under which the regulator has to act.

TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Letters, &c., for the "Correspondence" columns should arrive not later than Tuesday morning if they are desired to appear in the following number, such communications to be addressed to the "Editors," ELECTRICAL REVIEW, 22, Paternoster Row, London, E.C.

Letters respecting Advertisements, Subscriptions, &c., should be sent to the "Publisher," ELECTRICAL REVIEW, at above address.

SUBSCRIPTION RATES.

THE ELECTRICAL REVIEW can be had, by order, from any newsagent in town or country; or it can be supplied direct from the office on the following terms (payable in advance):—

Half-yearly (postage included)	...	...	9s. 9d.
Yearly ,, ,,	...	...	19s. 6d.

FOREIGN SUBSCRIPTION RATES.

To all foreign countries (except those mentioned below):—

Half-yearly (postage included)	...	...	10s. 10d.
Yearly ,, ,,	...	...	21s. 8d.

Exceptions:—Abyssinia, Aden, Borneo, Ceylon, India, Java, Labuan, Mozambique, Penang, Persia *viâ* Brindisi, Philippine Islands, Singapore, Zanzibar, to which places the rates are:—

Half-yearly (postage included)	...	...	11s. 11d.
Yearly ,, ,,	...	...	23s. 10d.

Vol. XI., handsomely bound, in cloth, gilt, now ready. Vols. 1, 2, 5, 6, 7, 8, 9, 10, can likewise be had.

A few complete sets also may yet be obtained. Prices on application to the Publisher.

Cloth cases for binding THE ELECTRICAL REVIEW supplied.

ADVERTISEMENTS.

The rates for Advertisements may be obtained on application to the Publisher, ELECTRICAL REVIEW, 22, Paternoster Row, London, E.C.

Cheques and Post-office Orders (on Chief Office, London) to be made payable to H. ALABASTER.

CORRESPONDENCE.

The Efficiency of Electro-Motors.

You kindly published my letter of the 26th May asking Professors Ayrton and Perry to favour me by the publication of the data on which is based their statement that the efficiency of the Griscom motor is 17 per cent. No reply having appeared from these gentlemen, I presume my letter escaped their attention.

As it is possible to obtain very varying degrees of good or bad efficiency from an electric-motor depending on the use to which they are put, if the gentlemen named will give the data on which they base their statement, the method of measuring power, the speed at which the motor was run, the current used, and the E.M.F. at the motor-terminals, I shall be able to say where the mistake, if any, was made.

C. R. Heap,
General Agent.

London, *June 18th*, 1883.

Kempe's Handbook of Electrical Testing.

Some gentlemen to whom I have been showing Mr. Kempe's handbook are desirous of obtaining copies. Messrs. Spon inform them that the 2nd edition is out of print. Will you kindly insert a line in Journal saying when the 3rd edition is likely to be issued, and oblige us?

Fareham.

[Directly the 3rd edition is ready it will be notified in our columns. —EDS. ELEC. REV.]

On Winding Electro-Magnets.

The paper on this subject by Profs. W. E. Ayrton, F.R.S., and John Perry, M.E., published in the Review of June 16th, induces me to send you extracts from a book, published in 1864 by Count du Moncel, entitled "Traité Théorique et Pratique de Télégraphie Electrique." On pages 151-152 Count du Moncel writes:—"One of the means discovered by Descartes, and susceptible of being applied with great advantage to straight bar electro-magnets, consists in placing on the pole which is not used to attract the armature a mass of soft iron.

"The strength of the other pole is thus greatly stimulated, and this extra stimulation, as I have demonstrated, is greater as the surface of the added mass is more developed. This increase of force nevertheless has a limit, after which there is a change of sign in the effect obtained when the mass is increased. I have shown that this increase of force does not proceed from the increased size of the magnetic core, but from the extra stimulation produced by the action between the inactive pole and the mass of iron attached to it.

"If we place near the end of one of the poles of an electro-magnet all the coil which a given magnetising helix is capable of receiving, the force of this pole is much greater than if the coil is spread out over the entire length of the bar, when even the number of turns of the coil are many times more in the last case than in the former. This increase of force in the former results from the fact that the portion of the bar not covered by the coil acts in the same manner as the mass of soft iron mentioned above."

From these extracts it appears that Count du Moncel, twenty years ago, demonstrated clearly the advantages of placing the coil near the end of the pole of an electro-magnet, and further he elucidated the cause which produces this advantage.

W. C. Barney.

Electric Launches.

I take the liberty of addressing you with reference to a small electrical launch, the *De la Motte*, which I have had built for the purpose of testing the value of batteries and motors for driving the same. Should you think the following notes would be of any interest to your numerous readers you are at liberty to publish them.

E. Toynbee.

18, Malvern Villas, Willesden, N.W.,
June 19th, 1883.

TRIAL TRIP OF THE "DE LA MOTTE," JUNE 18TH, 1883.

Battery—Bunsen's, with very dilute acids; it consisted of 37 elements, 20 zincs, 12 inches internal circumference and 2 inches in height, and 17 zincs of 5 inches high and the same diameter. These were connected in series without screws or clamps, &c., but by means of brass strips (varnished all over with Brunswick black, except at the points of contact, which are gilt) tied firmly over the top of the carbon by means of gilt copper wire, being soldered at the zinc end in the usual manner. These connections are very durable and cannot be broken with fair usage, very cheap, any one can make them, and they never get out of order. Acids used: 14 oz. of sulphuric acid (sp.g. 1·8) by measure, by weight 25 oz.; nitric acid, 2 quarts, of sp.g. 1·45 commercial, with 4 quarts of water. Zinc dissolved, presuming the whole of the sulphuric acid to be combined with oxide of zinc (which was far from being the case), would be 21 ounces.

Time of action of battery, 10 hours, or from one o'clock to 11 p.m.

Current derived by my galvanometer, 50°; number of centimeter cubes of hydrogen corresponding, 130cc. in 123 seconds.

Speed.—With a load of three-quarters of a ton and a boat 21 ft. long by 3 ft. 6 in. wide, say, 2 cwt. more, 3 miles per hour in still water, which can be increased *à volonté*.

Motor.—A full description of my patent motor, No. 3226, will accompany this. Briefly, it consists of a series of magnets forming in all one complete ring, upon the same shaft or axle together with the propeller, so as to avoid all dead points and so cut off at each part of the revolution that those which are doing little or no work are deprived of the current, and only those which are in full action are supplied with it. No intermediate gear being employed, the screw and armature magnets revolving on the two bearings, which are roller bearings.

Expense.—	d.
25 ounces of sulphuric acid at 1d. per lb., say.. ..	1¼
21 ounces of zinc at 5d. per lb., amalgamated, double rolled, say	7
5·8 lbs. of nitric acid at 3½d., sp. g. 1·45	20
Pence	28¼

Exclusive of the value of the sulphate of zinc.

As before stated, the acid was by no means used up, but the battery went nearly as well on our return at 11 p.m. as it did when we started at one o'clock in the afternoon; tested by the number of revolutions of propeller.

Fumes (or evolved gases) are entirely done away with as regards the passengers. Firstly, by using diluted acid. Secondly, by enclosing the whole battery in an air-tight chest, forming as it were a deck to the bow; this is accomplished very simply, by allowing the sides of the lid to drop into a well of water of 3 inches in depth and passing whatever traces of gas there may be through a wooden tap supplied with an india-rubber tube to pour away at the stern just below the surface of the water. I had the inside pitched, which makes the tank quite tight.

Boat.—This was built by Mr. Cole, of Hammersmith Bridge, and great care and attention he bestowed on the same.

Propeller.—Three blades, 13″ diameter, 2 ft. pitch. It ought to have been a two bladed one, as the motor and propeller work so uniformly, and are so evenly balanced.

Any further particulars your readers might wish to have supplied them I will readily give.

Secondary Generators.

Before examining the value of the conclusions arrived at by Mr. Kennedy, as described in his letters published in the ELECTRICAL REVIEW of the 9th and 16th inst., we must protest against the implication of "visionary enthusiasts" as applied to us. You would, we are sure, regret having employed such an expression did you know more of our scientific and industrial antecedents. We do not, however, desire to speak of ourselves. We had imagined you had closed the discussion, which you had yourself opened by the foot note to our letter of the 19th ult., published in your issue of the 19th May. It seems, however, that you have not appreciated the points covered by our invention; so without recapitulating what has already appeared in your columns from us, we would simply call your attention to the following extract from *Iron*, of April 27th, in order to render perfectly clear the advantages claimed for this system of distribution.

"It is pretty well established that the general and practical employment of electricity is dependent upon the following conditions: Firstly, the economical mechanical production of electric currents, which, wherever possible, should be produced by utilising natural forces. Secondly, the distribution over great distances, not of an electrical current, but of electrical energy, which is a very different matter, for every given current has special properties, and consumers should not be limited to the employment of special apparatus adapted to the given current, for this would be to discourage improvements in such apparatus. Thirdly, the distribution of electrical energy must be effected without permanent danger to consumers, and as far as possible to an unlimited extent. Lastly, the consumer should be able to transform this electrical energy into currents of every kind, and consequently adapted to every purpose already known, or that may hereafter be discovered, amongst the former being lighting by incandescence and by voltaic arc, chemical processes, such as electro-plating, and furnishing motive power. All these numerous conditions appear to be fulfilled by the Secondary Generators of Messrs. Gaulard & Gibbs."

What other system can fulfil all these conditions?

We now pass on to the discussion of Mr. Kennedy's experiments. It seems that Mr. Kennedy, after having placed some Maxim lamps and a Ruhmkorf coil on the same circuit of an alternating current dynamo, finds that when the secondary circuit of the Ruhmkorf is *open*, the primary current is *considerably* diminished, and that when the secondary is *closed* the diminution of the current in the primary is but small; and that he therefore concludes that in the first case a *counter* E.M.F. is developed in the primary circuit.

Now all these experiments were carried out by us long before they were made by Mr. Kennedy, for it is simply because *our* conclusions were not the same as *his* that the conception of our Secondary Generators had its origin.

From these experiments and from many others we came to the conclusion, in following up Arago's and Ampère's labours, "that the *movement* of the current in the primary generated a current in the thin wire of the secondary; that this secondary current being necessarily generated in an opposite direction to the primary current acted solely and simply as a resistance to the primary current. Furthermore, that this resistance was proportional to the E.M.F. of the secondary current generated, and to the resistance to be overcome in order to produce movement." Now if Mr. Kennedy, instead of exciting the powerful electro-magnet of a dynamo, had constructed a simple electro-magnet with but one layer of wire he would not have found this marked decrease in this current, which was simply due to the fact that the first layer of wire was causing induction to the second layer, the second layer to the third, and so on, for a counter E.M.F. was in this case certainly developed in the electro-magnet circuit. It is easy to understand that it would have been folly to think for a moment of "distribution by induction" if the *quantity* of the primary current was to be affected (as most electricians believe) by its passage through an induction coil, for in that case the power of each bobbin would certainly vary with the number of bobbins in circuit.

It was therefore only after having become certain of the nature of the phenomena resulting from the action of a secondary current upon a primary that it become possible to frame a theory for constructing such an instrument as ours, and to keep, in Ohm's formula

$$C = \frac{E}{R}$$

C constant by varying E proportionately to R, which in our case represents the number of generators placed on the circuit.

It would be too long here to recapitulate all the many experiments to which our apparatus owes its origin; but you may rest assured that the laws which govern them are numerous, and that the experiment above suggested to Mr. Kennedy is only one of many made by us, and to which we refer here since it brought about the invention of the induction cable with a central core, in order to avoid the self-induction of the layers of wire.

In a word, sir, we only desire to make everything quite clear, and we do not fear controversy, one condition, however, being that you do not in future remarks *entirely* ignore what we have said previously.

For { **Lucien Gaulard,** / **J. Dixon Gibbs,**
J. E. Pickering.

[We are pleased to insert the above letter. Messrs. Gaulard and Gibbs may rest assured that no one would take greater interest in their success than ourselves; and we hope that these discussions may be the means of enabling a true estimate of the value of their "secondary generators" to be arrived at.—EDS. ELEC. REV.]

The Maxim-Weston Electric Light Company.

Having just reached town my attention has been called to a letter in your issue, signed "F. H. Landon," referring to your report of the last meeting of the shareholders of this company. Not having seen said report I cannot vouch for its accuracy or otherwise, but what I stated to the meeting was that the late secretary, in a letter dated the 10th July, 1882 (shortly after I joined the board of the company), enclosed to me a statement showing the company's expenditure to be then at the rate of

Per week	£280
And Gross Income	69
	£211

from which I further deducted the estimated expenses connected with the City contract for lifting cable, &c., say £19 per week, included in above sum of £69 as income, making actual deficit £230 per week. Above was the only reference I made to the late secretary and I read his letter and statement to the meeting so as to give no cause for complaint.

H. Watt.

London, E.C., 20*th June*, 1883.